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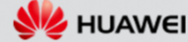
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华为认证系列教程

# HCDP-IESN
# 部署企业级交换网络
# 实验指导书




华为技术有限公司

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**华为认证系列教程**

**HCDP-IESN部署企业级交换网络**

**实验指导书**

**第1.6版本**

# 华为认证体系介绍

依托华为公司雄厚的技术实力和专业的培训体系，华为认证考虑到不同客户对ICT技术不同层次的需求，致力于为客户提供实战性、专业化的技术认证。

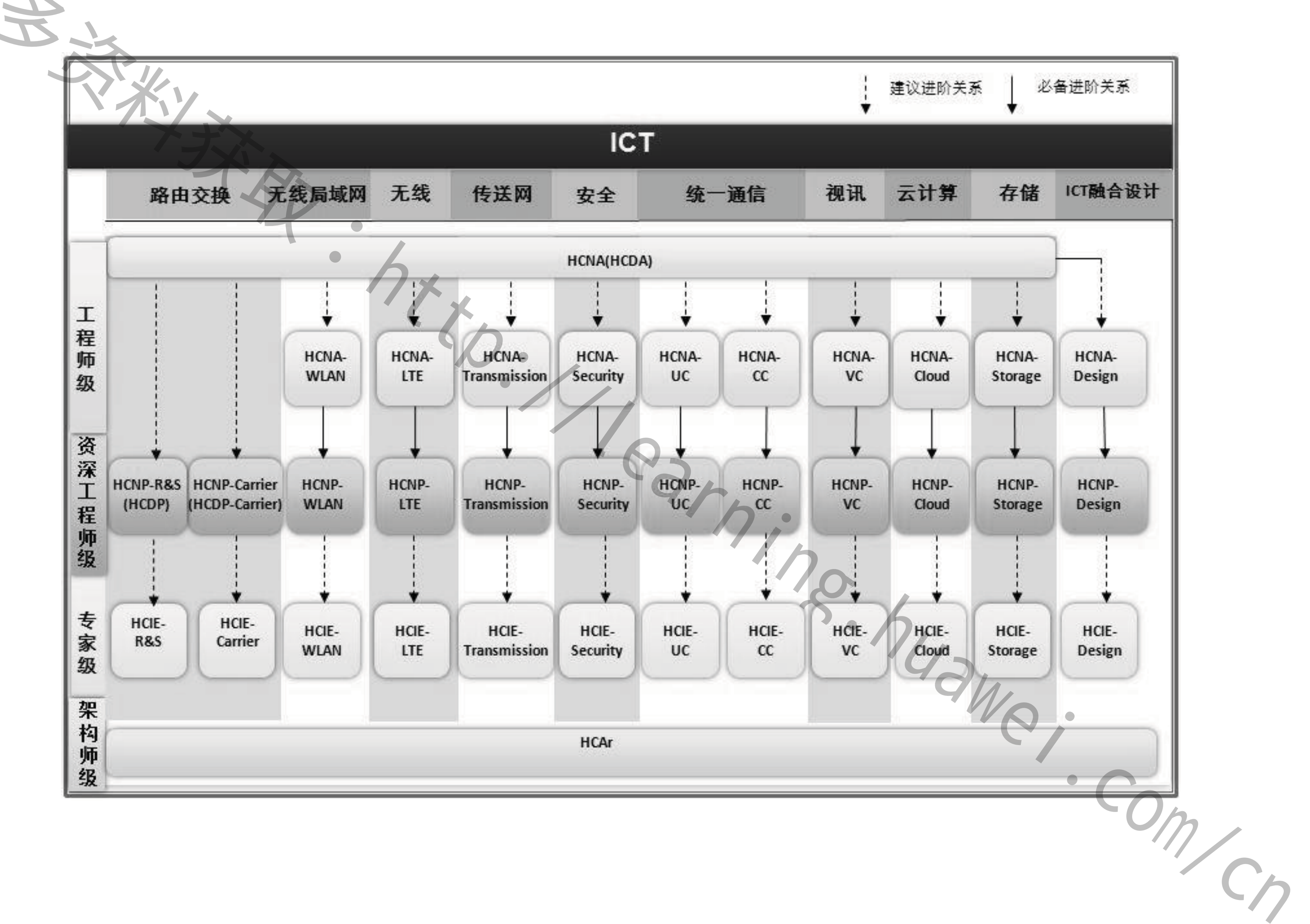
根据ICT技术的特点和客户不同层次的需求，华为认证为客户提供面向十三个方向的四级认证体系。

HCNA(HCDA)认证定位于中小型网络的基本配置和维护。HCNA(HCDA)认证包括但不限于：网络基础知识；流行网络的基本连接方法；基本的网络建造；基本的网络故障排除；华为路由交换设备的安装和调试。通过HCNA(HCDA)认证，将证明您对中小型网络有初步的了解，了解面向中小型企业的网络通用技术，并具备协助设计中小企业网络以及使用华为路由交换设备实施设计的能力。拥有通过HCNA(HCDA)认证的工程师，意味着中小企业有能力完成基本网络搭建，并将基本的语音、无线、云、安全和存储集成到网络之中，满足各种应用对网络的使用需求。

HCNP-Enterprise (HCDP-Enterprise)认证定位于中小型网络的构建和管理。HCNP-Enterprise (HCDP-Enterprise)认证包括但不限于：网络基础知识；交换机和路由器原理；TCP/IP 协议簇；路由协议；访问控制；网络故障的排除；华为路由交换设备的安装和调试。通过HCNP-Enterprise (HCDP-Enterprise)认证，将证明您对中小型网络有全面深入的了解，掌握面向中小型企业的网络通用技术，并具备独立设计中小企业网络以及使用华为路由交换设备实施设计的能力。拥有通过HCNP-Enterprise (HCDP-Enterprise)认证的工程师，意味着中小企业有能力完成完整网络的搭建，将企业中所需的语音、无线、云、安全和存储全面地集成到网络之中，并且能满足各种应用对网络的使用需求，进而提供较高的安全性、可用性和可靠性。

HCIE-Enterprise 认证定位于大中型复杂网络的构建、优化和管理。HCIE-Enterprise 认证包括但不限于：不同网络和各种路由器交换机之间的互联；复杂连接问题的解决；使用技术解决方案提高带宽、缩短相应时间、最大限度地提高性能、加强安全性和支持全球应用；复杂网络的故障排除。通过HCIE-Enterprise 认证，将证明您对大型网络有全面深入的了解，掌握面向大型企业网络的技术，并具备独立设计各种企业网络以及使用华为路由交换设备实施设计的能力。拥有通过HCIE-Enterprise 认证的工程师，意味着大中企业有能力独立完成完整的网络搭建，将企业中所需的语音、无线、云、安全和存储全面地集成到网络之中，并且能满足各种应用对网络的使用需求；能够提供完整的故障排除能力；能根据企业和网络技术的发展，规划企业网络的发展，并提供高安全性、可用性和可靠性。

华为认证协助您打开行业之窗，开启改变之门，屹立在ICT世界的潮头浪尖！


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必备进阶关系
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无线
传送网
安全
统一通信
视讯
云计算
存储
ICT融合设计
工程师级
资深工程师级
专家级
架构师级
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HCNA-WLAN
HCNA-LTE
HCNA-Transmission
HCNA-Security
HCNA-UC
HCNA-CC
HCNA-VC
HCNA-Cloud
HCNA-Storage
HCNA-Design
HCNP-R&S (HCDP)
HCNP-Carrier (HCDP-Carrier)
HCNP-WLAN
HCNP-LTE
HCNP-Transmission
HCNP-Security
HCNP-UC
HCNP-CC
HCNP-VC
HCNP-Cloud
HCNP-Storage
HCNP-Design
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HCIE-Storage
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HCAr

## 本书常用图标



路由器



三层交换机



二层交换机



防火墙

网云

以太网线缆

串行线缆

# 实验环境说明

## 组网介绍

本实验环境面向准备HCDP-IESN考试的网络工程师，实验设备包括路由器5台，交换机4台，防火墙2台。每套实验环境适用于2名学员同时上机操作。

## 设备介绍

为了满足HCDP-IESN实验需要，建议每套实验环境采用以下配置：

设备名称、型号与版本的对应关系如下：

| 设备名称 | 设备型号 | 软件版本 |
|---|---|---|
| R1 | AR 2220 | Version 5.90（V200R001C01SPC300) |
| R2 | AR 2220 | Version 5.90（V200R001C01SPC300) |
| R3 | AR 2220 | Version 5.90（V200R001C01SPC300) |
| R4 | AR 1220 | Version 5.90（V200R001C01SPC300) |
| R5 | AR 1220 | Version 5.90（V200R001C01SPC300) |
| S1 | S5700-28C-EI-24S | Version 5.70 (V100R006C00SPC800) |
| S2 | S5700-28C-EI-24S | Version 5.70 (V100R006C00SPC800) |
| S3 | S3700-28TP-EI-AC | Version 5.70 (V100R006C00SPC800) |
| S4 | S3700-28TP-EI-AC | Version 5.70 (V100R006C00SPC800) |
| FW1 | USG2160 | Version 5.30 (V300R001C00SPC700) |
| FW2 | USG2160 | Version 5.30 (V300R001C00SPC700) |

# 目录

# 第一章 VLAN特性与配置

## 实验 1-1 VLAN 配置

### 学习目的

- 掌握VLAN的配置方法
- 掌握Eth-trunk的配置方法
- 理解Hybrid接口类型的应用场景

### 拓扑图

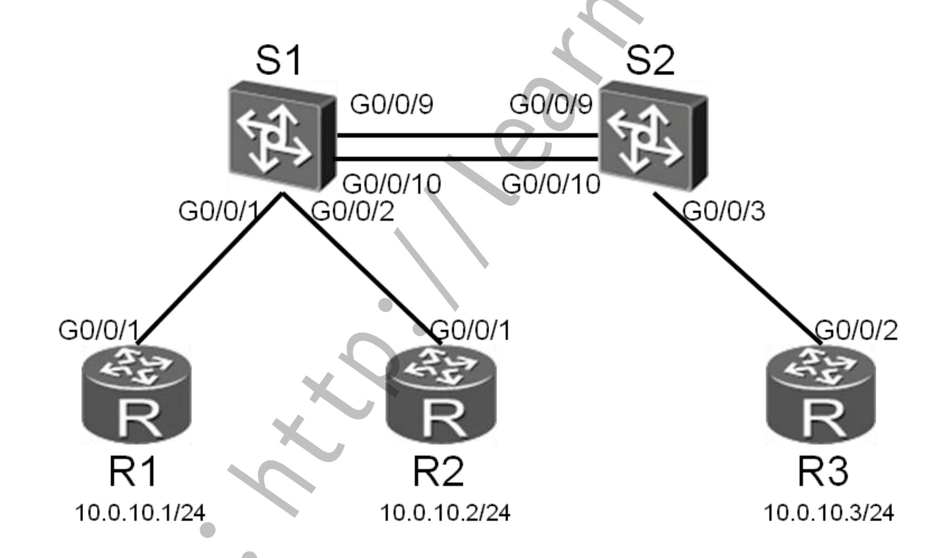



图1-1 VLAN配置

### 场景

你是公司的网络管理员。现在公司网络是由二台交换机组成的以太网环境。图中路由器模拟网络中的计算机，R3是一台服务器。为了优化这个网络，需要你提升S1和S2相连链路的速度和可靠性。并且创建二个VLAN，以实现广播域的互相隔离。R2和R3处于相同的VLAN中。同时为了方便访问服务器，你应该让

R1和R3能够正常通信。

## 学习任务

### 步骤一. 基础配置与 IP 编址

给所有设备配置IP地址和掩码。

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.10.1 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface GigabitEthernet 0/0/1
[R2-GigabitEthernet0/0/1]ip address 10.0.10.2 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ip address 10.0.10.3 24
```

给交换机配置名称。

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname S1

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname S2
```

### 步骤二. Eth-trunk 链路聚合

Eth-trunk可以将二条或多条链路捆绑成一条链路以提升链路带宽和可靠性。将S1和S2的G0/0/9和G0/0/10接口加入到同一个Eth-trunk组可以实现企业需

求。

创建Eth-trunk接口。

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]

[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]
```

配置Eth-trunk的工作模式为静态LACP模式。

```
[S1-Eth-Trunk1]bpdu enable
[S1-Eth-Trunk1]mode lacp-static

[S2-Eth-Trunk1]bpdu enable
[S2-Eth-Trunk1]mode lacp-static
```

将S1和S2的G0/0/9和G0/0/10接口加入到Eth-trunk接口。

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]eth-trunk 1
[S1-GigabitEthernet0/0/9]quit
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]eth-trunk 1

[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]eth-trunk 1
[S2-GigabitEthernet0/0/9]quit
[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]eth-trunk 1
```

使用命令**dispay eth-trunk**查看配置情况。

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                  WorkingMode: STATIC
Preempt Delay: Disabled      Hash arithmetic: According to SA-XOR-DA
System Priority: 32768       System ID: 4c1f-cc45-aace
Least Active-linknumber: 1  Max Active-linknumber: 8
Operate status: down        Number Of Up Port In Trunk: 0
-----------------------------------------------------------------------------
----
ActorPortName          Status    PortType PortPri PortNo PortKey PortState Weight
GigabitEthernet0/0/9    Selected 1GE      32768    9      305     10100010   1
```

```
GigabitEthernet0/0/10  Selected 1GE     32768   10    305    10100010  1

Partner:
-----------------------------------------------------------------------------
ActorPortName          SysPri    SystemID  PortPri PortNo  PortKey   PortState
GigabitEthernet0/0/9    0     0000-0000-0000  0      0     0        10100011
GigabitEthernet0/0/10   0     0000-0000-0000  0      0     0        10100011
```

输出信息显示，此时链路运行模式为静态LACP模式，并且最大活动接口数阈值是8条链路。同时G0/0/9和G0/0/10接口都处于活动状态。

使用命令更改活动接口数阈值。

```
[S1-Eth-Trunk1]max active-linknumber 1

[S2-Eth-Trunk1]max active-linknumber 1
```

查看Eth-trunk链路配置情况。

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                WorkingMode: STATIC
Preempt Delay: Disabled    Hash arithmetic: According to SA-XOR-DA
System Priority: 32768     System ID: 4c1f-cc45-aace
Least Active-linknumber: 1  Max Active-linknumber: 1
Operate status: up         Number Of Up Port In Trunk: 1
-----------------------------------------------------------------------------
ActorPortName          Status   PortType PortPri PortNo PortKey PortState Weight
GigabitEthernet0/0/9    Selected 1GE     32768   9     305    10111100  1
GigabitEthernet0/0/10  Unselect 1GE     32768   10    305    10100000  1

Partner:
-----------------------------------------------------------------------------
ActorPortName          SysPri    SystemID  PortPri PortNo  PortKey   PortState
GigabitEthernet0/0/9    32768  4c1f-cc45-aacc  32768  9     305      10111100
GigabitEthernet0/0/10  32768  4c1f-cc45-aacc  32768  10    305      10100000
```

从输出信息可以看到，G0/0/10接口状态改变为Unselect。实现了Eth-trunk聚合链路下一条链路传输数据，另一条链路备份的功能，提升了网络可靠性。

通过关闭S1的G0/0/9接口验证备份链路功能。

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]shutdown
```

查看Eth-trunk链路信息。

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                 WorkingMode: STATIC
Preempt Delay: Disabled    Hash arithmetic: According to SA-XOR-DA
System Priority: 32768     System ID: 4c1f-cc45-aace
Least Active-linknumber: 1  Max Active-linknumber: 1
Operate status: up         Number Of Up Port In Trunk: 1
--------------------------------------------------------------------------------
ActorPortName          Status   PortType PortPri PortNo PortKey PortState Weight
GigabitEthernet0/0/9   Unselect 1GE      32768   9      305     10100010  1
GigabitEthernet0/0/10  Selected 1GE      32768   10     305     10111100  1

Partner:
--------------------------------------------------------------------------------
ActorPortName          SysPri   SystemID  PortPri PortNo PortKey   PortState
GigabitEthernet0/0/9   0      0000-0000-0000  0     0     0        10100011
GigabitEthernet0/0/10  32768  4c1f-cc45-aacc  32768  10    305      10111100
```

从输出信息看到Eth-trunk链路中G0/0/9已经变为Unselect状态，G0/0/10由Unselect状态自动转换为Selected状态继续传输数据。由此可知，实现了链路备份功能。

## 步骤三. VLAN 配置

在S1和S2上创建二个VLAN用于隔离R1和R2、R3。并将S1和S2之间的Eth-trunk链路配置成Trunk模式，实现相同VLAN之间的通信。

在S1和S2上创建VLAN10、VLAN20。

```
[S1]vlan batch 10 20

[S2]vlan batch 10 20
```

更改S1的G0/0/1和 G0/0/2接口为Access模式并加入到VLAN10

```
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port link-type access
[S1-GigabitEthernet0/0/1]port default vlan 10
[S1]interface GigabitEthernet 0/0/2
[S1-GigabitEthernet0/0/2]port link-type access
[S1-GigabitEthernet0/0/2]port default vlan 20
```

更改S2的G0/0/3接口为Access模式并加入到VLAN20。

```
[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/3]port link-type access
[S2-GigabitEthernet0/0/3]port default vlan 20
```

将S1和S2的Eth-trunk接口配置成Trunk接口，Trunk接口默认只允许VLAN 1通过，所以配置允许VLAN10、VLAN20通过。

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]port link-type trunk
[S1-Eth-Trunk1]port trunk allow-pass vlan 10 20

[S2]inter Eth-Trunk 1
[S2-Eth-Trunk1]port link-type trunk
[S2-Eth-Trunk1]port trunk allow-pass vlan 10 20
```

使用**display port vlan**命令查看Trunk接口的状态

```
[S2]display port vlan
Port                    Link Type    PVID  Trunk VLAN List
-----------------------------------------------------------------------------
GigabitEthernet0/0/1    hybrid       1     -
GigabitEthernet0/0/2    access       1    -
GigabitEthernet0/0/3    hybrid       20    -
GigabitEthernet0/0/4    hybrid       1     -
GigabitEthernet0/0/5    hybrid       1     -
GigabitEthernet0/0/6    hybrid       1     -
GigabitEthernet0/0/7    hybrid       1     -
GigabitEthernet0/0/8    hybrid       1     -
GigabitEthernet0/0/9    hybrid       0     -
GigabitEthernet0/0/10   hybrid       0     -
GigabitEthernet0/0/11   hybrid       1     -
GigabitEthernet0/0/12   hybrid       1     -
GigabitEthernet0/0/13   hybrid       1     -
GigabitEthernet0/0/14   hybrid       1     -
GigabitEthernet0/0/15   hybrid       1     -
GigabitEthernet0/0/16   hybrid       1     -
GigabitEthernet0/0/17   hybrid       1     -
GigabitEthernet0/0/18   hybrid       1     -
GigabitEthernet0/0/19   hybrid       1     -
GigabitEthernet0/0/20   hybrid       1     -
GigabitEthernet0/0/21   hybrid       1     -
GigabitEthernet0/0/22   hybrid       1     -
GigabitEthernet0/0/23   hybrid       1     -
GigabitEthernet0/0/24   hybrid       1     -
```

```
Eth-Trunk1                trunk        1     1 10 20
```

从输出信息看到Eth-trunk接口已经正确配置为Trunk接口并允许VLAN 10和VLAN 20通信。

使用**ping**命令测试R2和R1、R3的连通性。

```
[R2]ping -c 1 10.0.10.1
  PING 10.0.10.1: 56  data bytes, press CTRL_C to break
    Request time out

  --- 10.0.10.1 ping statistics ---
    1 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss

[R2]ping -c 1 10.0.10.3
  PING 10.0.10.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.3: bytes=56 Sequence=1 ttl=255 time=3 ms

  --- 10.0.10.3 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms
```

测试结果表示，在通过Trunk链路连接的二个交换机上不同VLAN的计算机不能互相通信，相同VLAN的计算机能够互相通信。

## 步骤四. 配置 Hybrid 接口

Hybrid接口可以实现R1和R3之间二层模式下的通信。通过和Trunk接口的对比掌握Hybrid接口的配置和特性。

配置一：S1和S2之间的连线为Trunk接口的情况

更改S1的G0/0/1接口为Hybrid模式，并加入VLAN 10。同时配置实现发送VLAN 20的数据包时去掉VLAN标记的功能。

```
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port default vlan 1
[S1-GigabitEthernet0/0/1]port link-type hybrid
[S1-GigabitEthernet0/0/1]port hybrid pvid vlan 10
[S1-GigabitEthernet0/0/1]port hybrid tagged vlan 10
[S1-GigabitEthernet0/0/1]port hybrid untagged vlan 10 20
```



更改S2的G0/0/3接口为Hybrid模式，并加入VLAN 20。同时配置实现发送VLAN 10的数据包时去掉VLAN标记的功能。

```
[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/3]port default vlan 1
[S2-GigabitEthernet0/0/3]port link-type hybrid
[S2-GigabitEthernet0/0/3]port hybrid pvid vlan 20
[S2-GigabitEthernet0/0/3]port hybrid untagged vlan 10 20
```

使用命令**display vlan**、**display port vlan**命令查看接口情况。

```
[S1]display vlan 20
* : management-vlan
---------------------
VLAN ID Type        Status   MAC Learning Broadcast/Multicast/Unicast Property
----------------------------------------------------------------------------
20      common       enable   enable      forward  forward   forward default
----------------
Untagged   Port: GigabitEthernet0/0/1          GigabitEthernet0/0/2

----------------
Tagged     Port: Eth-Trunk1
----------------
Interface                 Physical
Eth-Trunk1                UP
GigabitEthernet0/0/1        UP
GigabitEthernet0/0/2        UP

[S1]dis
[S1]display port vlan
Port                     Link Type    PVID  Trunk VLAN List
----------------------------------------------------------------------------
GigabitEthernet0/0/1    hybrid        10    -
GigabitEthernet0/0/2    access        20    -
GigabitEthernet0/0/3    hybrid        1     -
GigabitEthernet0/0/4    hybrid        1     -
GigabitEthernet0/0/5    hybrid        1     -
GigabitEthernet0/0/6    hybrid        1     -
GigabitEthernet0/0/7    hybrid        1     -
GigabitEthernet0/0/8    hybrid        1     -
GigabitEthernet0/0/9    hybrid        0     -
GigabitEthernet0/0/10   hybrid        0     -
GigabitEthernet0/0/11   hybrid        1     -
```

```
GigabitEthernet0/0/12   hybrid      1    -
GigabitEthernet0/0/13   hybrid      1    -
GigabitEthernet0/0/14   hybrid      1    -
GigabitEthernet0/0/15   hybrid      1    -
GigabitEthernet0/0/16   hybrid      1    -
GigabitEthernet0/0/17   hybrid      1    -
GigabitEthernet0/0/18   hybrid      1    -
GigabitEthernet0/0/19   hybrid      1    -
GigabitEthernet0/0/20   hybrid      1    -
GigabitEthernet0/0/21   hybrid      1    -
GigabitEthernet0/0/22   hybrid      1    -
GigabitEthernet0/0/23   hybrid      1    -
GigabitEthernet0/0/24   hybrid      1    -
Eth-Trunk1            trunk       1     1 10 20

[S2]display vlan 10
* : management-vlan
---------------------
VLAN ID Type        Status   MAC Learning Broadcast/Multicast/Unicast Property
----------------------------------------------------------------------------
10      common      enable   enable      forward  forward   forward default
----------------
Untagged  Port: GigabitEthernet0/0/3
----------------
Tagged    Port: Eth-Trunk1
----------------
Interface                Physical
Eth-Trunk1               UP
GigabitEthernet0/0/3       UP

[S2]display port vlan
Port                    Link Type    PVID  Trunk VLAN List
----------------------------------------------------------------------------
GigabitEthernet0/0/1    hybrid      1    -
GigabitEthernet0/0/2    hybrid      1    -
GigabitEthernet0/0/3    hybrid      20   -
GigabitEthernet0/0/4    hybrid      1    -
GigabitEthernet0/0/5    hybrid      1    -
GigabitEthernet0/0/6    hybrid      1    -
GigabitEthernet0/0/7    hybrid      1    -
GigabitEthernet0/0/8    hybrid      1    -
GigabitEthernet0/0/9    hybrid      0    -
GigabitEthernet0/0/10   hybrid      0    -
```

```
GigabitEthernet0/0/11   hybrid      1    -
GigabitEthernet0/0/12   hybrid      1    -
GigabitEthernet0/0/13   hybrid      1    -
GigabitEthernet0/0/14   hybrid      1    -
GigabitEthernet0/0/15   hybrid      1    -
GigabitEthernet0/0/16   hybrid      1    -
GigabitEthernet0/0/17   hybrid      1    -
GigabitEthernet0/0/18   hybrid      1    -
GigabitEthernet0/0/19   hybrid      1    -
GigabitEthernet0/0/20   hybrid      1    -
GigabitEthernet0/0/21   hybrid      1    -
GigabitEthernet0/0/22   hybrid      1    -
GigabitEthernet0/0/23   hybrid      1    -
GigabitEthernet0/0/24   hybrid      1    -
Eth-Trunk1            trunk       1    1 10 20
```

从输出信息可以看到S1的G0/0/1接口对VLAN 20的数据不打标记，同时G0/0/1的接口PVID属于VLAN 10。S2的G0/0/3接口对VLAN 10的数据不打标记，同时G0/0/3的接口PVID属于VLAN 20。

使用**ping**命令测试R1和R2、R3之间的连通性。

```
[R1]ping -c 1 10.0.10.2
  PING 10.0.10.2: 56  data bytes, press CTRL_C to break
    Request time out

  --- 10.0.10.2 ping statistics ---
    1 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss

[R1]ping -c 1 10.0.10.3
  PING 10.0.10.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.3: bytes=56 Sequence=1 ttl=255 time=13 ms

  --- 10.0.10.3 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 13/13/13 ms
```

配置二：S1和S2之间的连线为Hybrid接口的情况

更改S1和S2的Eth-trunk接口为Hybrid模式。在S1的Eth-trunk接口上

Untagged VLAN 20，S2的Eth-trunk接口上Untagged VLAN 10。

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]undo port trunk allow-pass vlan 10 20
[S1-Eth-Trunk1]port link-type hybrid
[S1-Eth-Trunk1]port hybrid untagged vlan 10

[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]undo port trunk allow-pass vlan 10 20
[S2-Eth-Trunk1]port link-type hybrid
[S2-Eth-Trunk1]port hybrid untagged vlan 20
```

查看Eth-trunk 1接口配置信息。

```
[S1]display port vlan
Port                 Link Type    PVID  Trunk VLAN List
-------------------------------------------------------------------------------
GigabitEthernet0/0/1    hybrid      10    10
GigabitEthernet0/0/2    access      20    -
GigabitEthernet0/0/3    hybrid      1     -
GigabitEthernet0/0/4    hybrid      1     -
GigabitEthernet0/0/5    hybrid      1     -
GigabitEthernet0/0/6    hybrid      1     -
GigabitEthernet0/0/7    hybrid      1     -
GigabitEthernet0/0/8    hybrid      1     -
GigabitEthernet0/0/9    hybrid      0     -
GigabitEthernet0/0/10   hybrid      0     -
GigabitEthernet0/0/11   hybrid      1     -
GigabitEthernet0/0/12   hybrid      1     -
GigabitEthernet0/0/13   hybrid      1     -
GigabitEthernet0/0/14   hybrid      1     -
GigabitEthernet0/0/15   hybrid      1     -
GigabitEthernet0/0/16   hybrid      1     -
GigabitEthernet0/0/17   hybrid      1     -
GigabitEthernet0/0/18   hybrid      1     -
GigabitEthernet0/0/19   hybrid      1     -
GigabitEthernet0/0/20   hybrid      1     -
GigabitEthernet0/0/21   hybrid      1     -
GigabitEthernet0/0/22   hybrid      1     -
GigabitEthernet0/0/23   hybrid      1     -
GigabitEthernet0/0/24   hybrid      1     -
Eth-Trunk1            hybrid      1     -

[S1]display vlan 10
```

```
* : management-vlan
---------------------
VLAN ID Type        Status   MAC Learning Broadcast/Multicast/Unicast Property
----------------------------------------------------------------------------
10      common      enable   enable      forward   forward   forward default
----------------
Untagged   Port: Eth-Trunk1
----------------
Tagged     Port: GigabitEthernet0/0/1
----------------
Interface                Physical
Eth-Trunk1               UP
GigabitEthernet0/0/1       UP
```

输出信息可以看到S1的Eth-trunk 1接口已经正确配置为Hybrid类型并按需求对VLAN 20不标记。S2情况相似。

使用**ping**命令测试R1和R2、R3之间的连通性。

```
[R1]ping -c 1 10.0.10.2
  PING 10.0.10.2: 56  data bytes, press CTRL_C to break
    Request time out

  --- 10.0.10.2 ping statistics ---
    1 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss

[R1]ping -c 1 10.0.10.3
  PING 10.0.10.3: 56  data bytes, press CTRL_C to break
    Request time out

  --- 10.0.10.3 ping statistics ---
    1 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss
```

通信无法成功。原因R1和R3连接的接口没有正确的识别VLAN标记。

删除S1的G0/0/1接口和S2的G0/0/3接口的Untagged配置，都重新配置**Untagged VLAN 1**命令

```
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]undo port hybrid vlan 20
[S1-GigabitEthernet0/0/1]port hybrid untagged vlan 1
```

```
[S2]interface GigabitEthernet 0/0/3
[S2-GigabitEthernet0/0/1]undo port hybrid vlan 10
[S2-GigabitEthernet0/0/1]port hybrid untagged vlan 1
```

使用**ping**命令测试R1、R2、R3之间的连通性

```
[R1]ping -c 1 10.0.10.2
  PING 10.0.10.2: 56  data bytes, press CTRL_C to break
    Request time out

  --- 10.0.10.2 ping statistics ---
    1 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss

[R1]ping -c 1 10.0.10.3
  PING 10.0.10.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.3: bytes=56 Sequence=1 ttl=255 time=2 ms

  --- 10.0.10.3 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 2/2/2 ms
```

通过更改S1的G0/0/1和S2的G0/0/3接口的Untagged参数为VLAN 1实现了R1和R3之间的通信。

## 附加实验：思考并验证

在步骤四中S1和S2相连的Eth-trunk接口使用Trunk模式和使用Hybrid模式时，数据在传播的过程中有什么区别？

## 最终设备配置

```
[S1]display current-configuration
#
!Software Version V100R005C01SPC100
 sysname S1
#
```

```
 vlan batch 10 20
#
 stp mode rstp
 stp enable
#
 undo http server enable
#
interface Eth-Trunk1
 port hybrid untagged vlan 10
 mode lacp-static
 max active-linknumber 1
 bpdu enable
#
interface GigabitEthernet0/0/1
 port hybrid pvid vlan 10
 port hybrid tagged vlan 10
#
interface GigabitEthernet0/0/2
 port link-type access
 port default vlan 20
#
interface GigabitEthernet0/0/3
 shutdown
#
interface GigabitEthernet0/0/4
 shutdown
#
interface GigabitEthernet0/0/9
 shutdown
 eth-trunk 1
#
interface GigabitEthernet0/0/10
 eth-trunk 1
#
interface GigabitEthernet0/0/13
 shutdown
#
interface GigabitEthernet0/0/14
 shutdown
#
interface GigabitEthernet0/0/21
 shutdown
#
```

```
interface GigabitEthernet0/0/22
 shutdown
#
interface GigabitEthernet0/0/23
 shutdown
#
Return

[S2]display current-configuration
#
!Software Version V100R005C01SPC100
 sysname S2
#
 vlan batch 10 20
#
 stp mode rstp
 stp enable
#
interface Eth-Trunk1
 port hybrid untagged vlan 20
 mode lacp-static
 max active-linknumber 1
 bpdu enable
#
interface GigabitEthernet0/0/1
 shutdown
#
interface GigabitEthernet0/0/2
 shutdown
#
interface GigabitEthernet0/0/3
 port hybrid pvid vlan 20
 port hybrid tagged vlan 20
#
interface GigabitEthernet0/0/4
 shutdown
#
interface GigabitEthernet0/0/5
 shutdown
#
interface GigabitEthernet0/0/9
 eth-trunk 1
#
```

```
interface GigabitEthernet0/0/10
 eth-trunk 1
#
interface GigabitEthernet0/0/11
 shutdown
#
interface GigabitEthernet0/0/12
 shutdown
#
interface GigabitEthernet0/0/13
 shutdown
#
interface GigabitEthernet0/0/23
 shutdown
#
interface GigabitEthernet0/0/24
 shutdown
#
return
```

# 实验 1-2 MUX VLAN 和 GVRP 配置（选做）

## 学习目的

- 掌握GVRP的配置方法
- 掌握MUX VLAN的配置方法
- 了解自动模式下的Voice VLAN配置方法

## 拓扑图

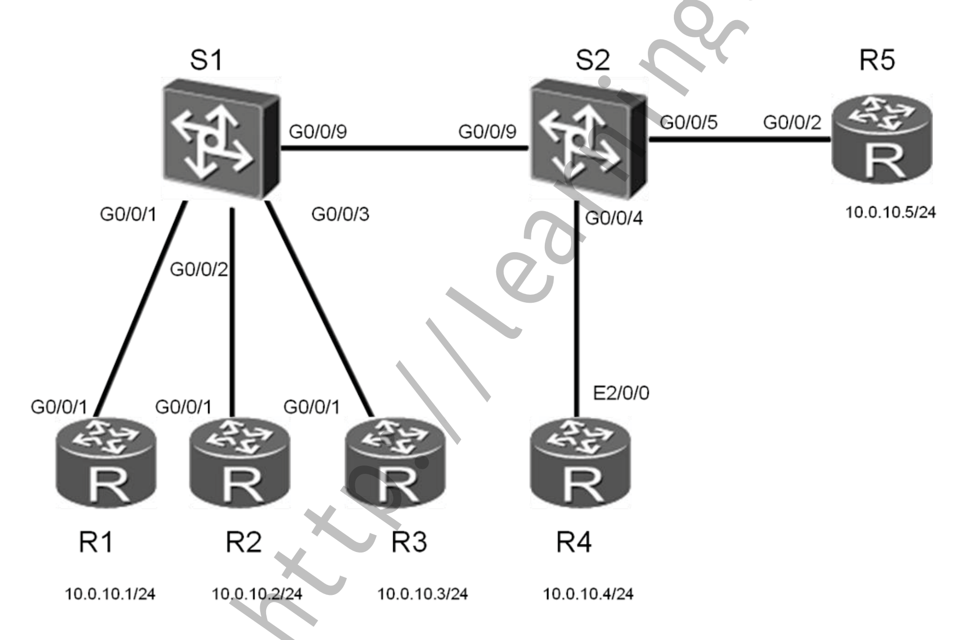



图1-2 MUX VLAN和GVRP配置

## 场景

你是公司的网络管理员。现在公司网络是由二台交换机组成的以太网环境。图中路由器代表网络中的计算机。为了优化这个网络，需要你实现广播域的互相隔离。R1和R2处于相同的VLAN中，R3和R4分别处另一个VLAN中。公司策略需要所有PC均可以访问R4 ,R3和R4除了不能与R1、R2通信外也不能互相访问。未来在S2的G0/0/24接口会使用语音设备，请提前规划语音VLAN及相关配置。

# 学习任务

## 步骤一. 基础配置与 IP 编址

给所有设备配置IP地址和掩码。

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]interface g0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.10.1 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface g0/0/1
[R2-GigabitEthernet0/0/1]ip address 10.0.10.2 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
[R3]interface g0/0/1
[R3-GigabitEthernet0/0/1]ip address 10.0.10.3 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R4
[R4]interface Ethernet2/0/0
[R4-Ethernet2/0/0]ip address 10.0.10.4 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R5
[R5]interface Ethernet2/0/0
[R5-Ethernet2/0/0]ip address 10.0.10.5 24

<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S1
[S1]

<Quidway>system-view
```

```
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S2
[S2]
```

在R1上测试与R2、R3、R4和R5的连通性。

```
[R1]ping -c 1 10.0.10.2
  PING 10.0.10.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.2: bytes=56 Sequence=1 ttl=255 time=14 ms

  --- 10.0.10.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 14/14/14 ms

[R1]ping -c 1 10.0.10.3
  PING 10.0.10.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.3: bytes=56 Sequence=1 ttl=255 time=5 ms

  --- 10.0.10.3 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 5/5/5 ms

[R1]ping -c 1 10.0.10.4
  PING 10.0.10.4: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.4: bytes=56 Sequence=1 ttl=255 time=15 ms

  --- 10.0.10.4 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 15/15/15 ms

[R1]ping -c 1 10.0.10.5
  PING 10.0.10.5: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.5: bytes=56 Sequence=1 ttl=255 time=6 ms

  --- 10.0.10.5 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
```

```
round-trip min/avg/max = 6/6/6 ms
```

## 步骤二. GVRP

GVRP可以在网络中传播VLAN信息，提高了网络管理员配置VLAN的效率。通过将S2的G0/0/9接口注册为Fixed模式，S1的G0/0/9接口注册为Normal模式，使得S1能够学习S2的VLAN配置。

将S1的G0/0/9接口和S2的G0/0/9接口配置为Trunk模式，并允许所有VLAN通过。

```
[S1]interface g0/0/9
[S1-GigabitEthernet0/0/9]port link-type trunk
[S1-GigabitEthernet0/0/9]port trunk allow-pass vlan all

[S1]interface g0/0/9
[S1-GigabitEthernet0/0/9]port link-type trunk
[S1-GigabitEthernet0/0/9]port trunk allow-pass vlan all
```

启用交换机S1和S2的GVRP功能。

```
[S1]gvrp

[S2]gvrp
```

使用命令**display gvrp status**查看GVRP开启状态信息。

```
[S1]display gvrp status
 GVRP is enabled

[S2]display gvrp status
 GVRP is enabled
```

配置S1的G0/0/9接口注册为Normal模式。

```
[S1]interface g0/0/9
[S1-GigabitEthernet0/0/9]gvrp
[S1-GigabitEthernet0/0/9]gvrp registration normal
[S1-GigabitEthernet0/0/9]bpdu enable
```

配置S2的G0/0/9接口注册为Fixed模式。

```
[S2]interface g0/0/9
[S2-GigabitEthernet0/0/9]gvrp
```

```
[S2-GigabitEthernet0/0/9]gvrp registration fixed
[S2-GigabitEthernet0/0/9]bpdu enable
```

使用命令**display gvrp statistics**查看GVRP状态信息。

```
[S1]display gvrp statistics

  GVRP statistics on port GigabitEthernet0/0/9
    GVRP status                      : Enabled
    GVRP registrations failed          : 0
    GVRP last PDU origin                     : 4c1f-cc45-aacc
    GVRP registration type             : Normal
```

使用命令**display vlan**查看当前状态下S1的VLAN信息。

```
[S1]display vlan
The total number of vlans is : 1
----------------------------------------------------------------------------
U: Up;        D: Down;        TG: Tagged;        UT: Untagged;
MP: Vlan-mapping;             ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
----------------------------------------------------------------------------
VID  Type    Ports
----------------------------------------------------------------------------
1    common  UT:GE0/0/1(U)      GE0/0/2(U)      GE0/0/3(U)      GE0/0/4(U)
               GE0/0/5(U)      GE0/0/6(D)      GE0/0/7(D)      GE0/0/8(D)
               GE0/0/9(U)      GE0/0/10(D)     GE0/0/11(D)     GE0/0/12(D)
               GE0/0/13(D)     GE0/0/14(D)     GE0/0/15(D)     GE0/0/16(D)
               GE0/0/17(D)     GE0/0/18(D)     GE0/0/19(D)     GE0/0/20(D)
               GE0/0/21(D)     GE0/0/22(D)     GE0/0/23(D)     GE0/0/24(D)

VID  Status  Property     MAC-LRN Statistics Description
----------------------------------------------------------------------------
1    enable  default      enable  disable    VLAN 0001
```

在S2上创建VLAN 10、20、100。

```
[S2]vlan batch 10 20 100
Info: This operation may take a few seconds. Please wait for a moment...done.
```

在S1上再次查看VLAN信息。

```
[S1]display vlan
The total number of vlans is : 4
----------------------------------------------------------------------------
```

```
U: Up;         D: Down;         TG: Tagged;         UT: Untagged;
MP: Vlan-mapping;               ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
----------------------------------------------------------------------------
VID  Type    Ports
----------------------------------------------------------------------------
1    common  UT:GE0/0/1(U)     GE0/0/2(U)     GE0/0/3(U)     GE0/0/4(U)
               GE0/0/5(U)     GE0/0/6(D)     GE0/0/7(D)     GE0/0/8(D)
               GE0/0/9(U)     GE0/0/10(D)    GE0/0/11(D)    GE0/0/12(D)
               GE0/0/13(D)    GE0/0/14(D)    GE0/0/15(D)    GE0/0/16(D)
               GE0/0/17(D)    GE0/0/18(D)    GE0/0/19(D)    GE0/0/20(D)
               GE0/0/21(D)    GE0/0/22(D)    GE0/0/23(D)    GE0/0/24(D)
10   dynamic TG:GE0/0/9(U)
20   dynamic TG:GE0/0/9(U)
100  dynamic TG:GE0/0/9(U)

VID  Status  Property     MAC-LRN Statistics Description
----------------------------------------------------------------------------
1    enable  default      enable  disable    VLAN 0001
10   enable  default      enable  disable    VLAN 0010
20   enable  default      enable  disable    VLAN 0020
100  enable  default      enable  disable    VLAN 0100
```

从命令输出结果可知S2的VLAN信息已经被S1学习到。

在S1上创建VLAN 30，观察S1的VLAN信息和S2的VLAN信息变化情况。

```
[S1]vlan 30
[S1-vlan30]quit
[S1]display vlan
The total number of vlans is : 5
----------------------------------------------------------------------------
U: Up;         D: Down;         TG: Tagged;         UT: Untagged;
MP: Vlan-mapping;               ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
----------------------------------------------------------------------------

VID  Type    Ports
----------------------------------------------------------------------------
1    common  UT:GE0/0/1(U)     GE0/0/2(U)     GE0/0/3(U)     GE0/0/4(U)
               GE0/0/5(U)     GE0/0/6(D)     GE0/0/7(D)     GE0/0/8(D)
               GE0/0/9(U)     GE0/0/10(D)    GE0/0/11(D)    GE0/0/12(D)
               GE0/0/13(D)    GE0/0/14(D)    GE0/0/15(D)    GE0/0/16(D)
               GE0/0/17(D)    GE0/0/18(D)    GE0/0/19(D)    GE0/0/20(D)
```

```
              GE0/0/21(D)    GE0/0/22(D)    GE0/0/23(D)    GE0/0/24(D)
10   dynamic TG:GE0/0/9(U)
20   dynamic TG:GE0/0/9(U)
30   common  TG:GE0/0/9(U)
100  dynamic TG:GE0/0/9(U)

VID  Status  Property     MAC-LRN Statistics Description
--------------------------------------------------------------------------------
1    enable  default      enable  disable    VLAN 0001
10   enable  default      enable  disable    VLAN 0010
20   enable  default      enable  disable    VLAN 0020
30   enable  default      enable  disable    VLAN 0030
100  enable  default      enable  disable    VLAN 0100

[S2]display vlan
The total number of vlans is : 4
--------------------------------------------------------------------------------
U: Up;        D: Down;        TG: Tagged;        UT: Untagged;
MP: Vlan-mapping;             ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
--------------------------------------------------------------------------------
VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:GE0/0/1(U)    GE0/0/2(U)     GE0/0/3(U)     GE0/0/4(U)
              GE0/0/5(U)     GE0/0/6(D)     GE0/0/7(D)     GE0/0/8(D)
              GE0/0/9(U)     GE0/0/10(D)    GE0/0/11(D)    GE0/0/12(D)
              GE0/0/13(D)    GE0/0/14(D)    GE0/0/15(D)    GE0/0/16(D)
              GE0/0/17(D)    GE0/0/18(D)    GE0/0/19(D)    GE0/0/20(D)
              GE0/0/21(D)    GE0/0/22(D)    GE0/0/23(D)    GE0/0/24(D)
10   common  TG:GE0/0/9(U)
20   common  TG:GE0/0/9(U)
100  common  TG:GE0/0/9(U)

VID  Status  Property     MAC-LRN Statistics Description
--------------------------------------------------------------------------------
1    enable  default      enable  disable    VLAN 0001
10   enable  default      enable  disable    VLAN 0010
20   enable  default      enable  disable    VLAN 0020
100  enable  default      enable  disable    VLAN 0100
```

从命令输出结果可知S2不会学习S1的VLAN信息。

## 步骤三. MUX VLAN

MUX VLAN可以实现处于相同网段的设备划入不同VLAN后，虽然二层通信是隔离的，但是还可以和同一个指定VLAN通信。并且还能实现禁止相同VLAN内不同设备之间的通信。

将VLAN 100配置为MUX VLAN的主VLAN，VLAN 10和20配置为从VLAN。

通过配置各PC与交换机相连接口的类型实现所有PC均可和R4通信，R3和R4不能和其他VLAN通信的同时也不能互相通信。

配置VLAN 100为主VLAN并添加从VLAN配置。

```
[S1]vlan 10
[S1-vlan10]quit
[S1]vlan 20
[S1-vlan20]quit
[S1]vlan 100
[S1-vlan100]mux-vlan
[S1-vlan100]subordinate group 10
[S1-vlan100]subordinate separate 20

[S2]vlan 100
[S2-vlan100]mux-vlan
[S2-vlan100]subordinate group 10
[S2-vlan100]subordinate separate 20
```

将R5与S2连接的G0/0/5接口加入VLAN 100并开启MUX VLAN功能。

```
[S2]interface GigabitEthernet 0/0/5
[S2-GigabitEthernet0/0/5]port link-type access
[S2-GigabitEthernet0/0/5]port default vlan 100
[S2-GigabitEthernet0/0/5]port mux-vlan enable
```

将R1与S1连接的G0/0/1和R2与S1连接的G0/0/2接口加入VLAN 10并开启MUX VLAN功能。

```
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port link-type access
[S1-GigabitEthernet0/0/1]port default vlan 10
[S1-GigabitEthernet0/0/1]port mux-vlan enable
[S1-GigabitEthernet0/0/1]interface GigabitEthernet 0/0/2
[S1-GigabitEthernet0/0/2]port link-type access
[S1-GigabitEthernet0/0/2]port default vlan 10
[S1-GigabitEthernet0/0/2]port mux-vlan enable
```

将R3与S1的G0/0/3和R4与S2的G0/0/4接口加入VLAN 20并开启MUX VLAN功能。

```
[S1]interface GigabitEthernet 0/0/3
[S1-GigabitEthernet0/0/3]port link-type access
[S1-GigabitEthernet0/0/3]port default vlan 20
[S1-GigabitEthernet0/0/3]port mux-vlan enable

[S2]interface GigabitEthernet 0/0/4
[S2-GigabitEthernet0/0/4]port link-type access
[S2-GigabitEthernet0/0/4]port default vlan 20
[S2-GigabitEthernet0/0/4]port mux-vlan enable
```

使用命令**display mux-vlan**查看所有MUX VLAN信息。

```
[S1]display mux-vlan
Principal Subordinate Type        Interface
----------------------------------------------------------------------------
100       -          principal
100       20         separate    GigabitEthernet0/0/3
100       10         group      GigabitEthernet0/0/1 GigabitEthernet0/0/2
```

```
[S2]display mux-vlan
Principal Subordinate Type        Interface
----------------------------------------------------------------------------
100       -          principal   GigabitEthernet0/0/5
100       20         separate    GigabitEthernet0/0/4
100       10         group
----------------------------------------------------------------------------
```

使用**ping**命令测试R1与R2、R3、R4、R5的连通性。

```
[R1]ping -c 1 10.0.10.2
  PING 10.0.10.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.2: bytes=56 Sequence=1 ttl=255 time=3 ms

  --- 10.0.10.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms

[R1]ping -c 1 10.0.10.3
```

```
 PING 10.0.10.3: 56  data bytes, press CTRL_C to break
   Request time out

 --- 10.0.10.3 ping statistics ---
   1 packet(s) transmitted
   0 packet(s) received
   100.00% packet loss

[R1]ping -c 1 10.0.10.4
 PING 10.0.10.4: 56  data bytes, press CTRL_C to break
   Request time out

 --- 10.0.10.4 ping statistics ---
   1 packet(s) transmitted
   0 packet(s) received
   100.00% packet loss

[R1]ping -c 1 10.0.10.5
 PING 10.0.10.5: 56  data bytes, press CTRL_C to break
   Reply from 10.0.10.5: bytes=56 Sequence=1 ttl=255 time=3 ms

 --- 10.0.10.5 ping statistics ---
   1 packet(s) transmitted
   1 packet(s) received
   0.00% packet loss
   round-trip min/avg/max = 3/3/3 ms
```

使用**ping**命令测试R3与R2、R4、R5的连通性。

```
[R3]ping -c 1 10.0.10.2
 PING 10.0.10.2: 56  data bytes, press CTRL_C to break
   Request time out

 --- 10.0.10.2 ping statistics ---
   1 packet(s) transmitted
   0 packet(s) received
   100.00% packet loss

[R3]ping -c 1 10.0.10.4
 PING 10.0.10.4: 56  data bytes, press CTRL_C to break
   Request time out

 --- 10.0.10.4 ping statistics ---
   1 packet(s) transmitted
```

```
    0 packet(s) received
    100.00% packet loss

[R3]ping -c 1 10.0.10.5
  PING 10.0.10.5: 56  data bytes, press CTRL_C to break
    Reply from 10.0.10.5: bytes=56 Sequence=1 ttl=255 time=3 ms

  --- 10.0.10.5 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms
```

从**ping**命令输出结果可知。 MUX VLAN中VLAN 10内部的R1和R2除了能够和R5通信外还能互相通信。VLAN 20内部的R3和R4仅仅能够和R5通信。

## 步骤四. Voice VLAN

为了应对未来企业的需求，我们将在S2交换机上启用Voice VLAN，并在G0/0/24接口上做相应配置。

在S2上创建VLAN 30和VLAN 200。VLAN 200作为语音VLAN使用。

```
[S2]vlan batch 30 200
Info: This operation may take a few seconds. Please wait for a moment...done.
```

配置S2的G0/0/24接口类型和缺省VLAN，假设未来语音设备属于VLAN 30。

```
[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]port hybrid pvid vlan 30
[S2-GigabitEthernet0/0/24]port hybrid untagged vlan 30
```

在S2上配置OUI地址。假设语音设备的MAC地址是0011-2200-0000，掩码是ffff-ff00-0000。

```
[S2]voice-vlan mac-address 0011-2200-0000 mask ffff-ff00-0000
```

配置S2的G0/0/24接口启用Voice VLAN功能和自动模式Voice VLAN功能。

```
[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]voice-vlan 200 enable
[S2-GigabitEthernet0/0/24]voice-vlan mode auto
[S2-GigabitEthernet0/0/24]voice-vlan security enable
```

使用命令**display voice-vlan oui**查看Voice VLAN的OUI地址配置。

```
[S2]display voice-vlan oui
---------------------------------------------------
OuiAddress      Mask           Description
---------------------------------------------------
0011-2200-0000  ffff-ff00-0000
```

使用命令**display voice-vlan 200 status**命令查看Voice VLAN配置信息。

```
[S2]display voice-vlan 200 status
Voice VLAN Configurations:
-----------------------------------------------------------
Voice VLAN ID           : 200
Voice VLAN status        : Enable
Voice VLAN aging time    : 1440(minutes)
Voice VLAN 8021p remark  : 6
Voice VLAN dscp remark   : 46
-----------------------------------------------------------
Port Information:
-----------------------------------------------------------
Port                    Add-Mode  Security-Mode  Legacy
-----------------------------------------------------------
GigabitEthernet0/0/24    Auto     Security      Disable
```

## 附加实验：思考并验证

属于二个不同的MUX VLAN之间的用户，互相通信是否能实现？

## 最终设备配置

```
[S1]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 10 20 30 100
#
 gvrp
#
vlan 100
 mux-vlan
 subordinate separate 20
```

```
 subordinate group 10
#
interface GigabitEthernet0/0/1
 port link-type access
 port default vlan 10
 port mux-vlan enable
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/2
 port link-type access
 port default vlan 10
 port mux-vlan enable
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/3
 port link-type access
 port default vlan 20
 port mux-vlan enable
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/9
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 undo ntdp enable
 undo ndp enable
 gvrp
#
interface GigabitEthernet0/0/10
 shutdown
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
Return

[S2]display current-configuration
#
```

```
!Software Version V100R006C00SPC800
 sysname S2
#
 voice-vlan mac-address 0011-2200-0000 mask ffff-ff00-0000
#
 vlan batch 10 20 30 100 200
#
 gvrp
#
vlan 100
 mux-vlan
 subordinate separate 20
 subordinate group 10
#
interface GigabitEthernet0/0/4
 port link-type access
 port default vlan 20
 port mux-vlan enable
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/5
 port link-type access
 port default vlan 100
 port mux-vlan enable
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/9
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 undo ntdp enable
 undo ndp enable
 gvrp
 gvrp registration fixed
#
interface GigabitEthernet0/0/10
 shutdown
 undo ntdp enable
 undo ndp enable
 bpdu disable
```

```
#
interface GigabitEthernet0/0/24
voice-vlan 200 enable
 port hybrid pvid vlan 30
 port hybrid untagged vlan 30
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
Return
```

# 实验 1-3 VLAN 间通信

## 学习目的

- 掌握多臂路由的配置方法
- 掌握单臂路由的配置方法
- 掌握VLAN间通信的配置方法
- 掌握VLAN聚合的配置方法

## 拓扑图

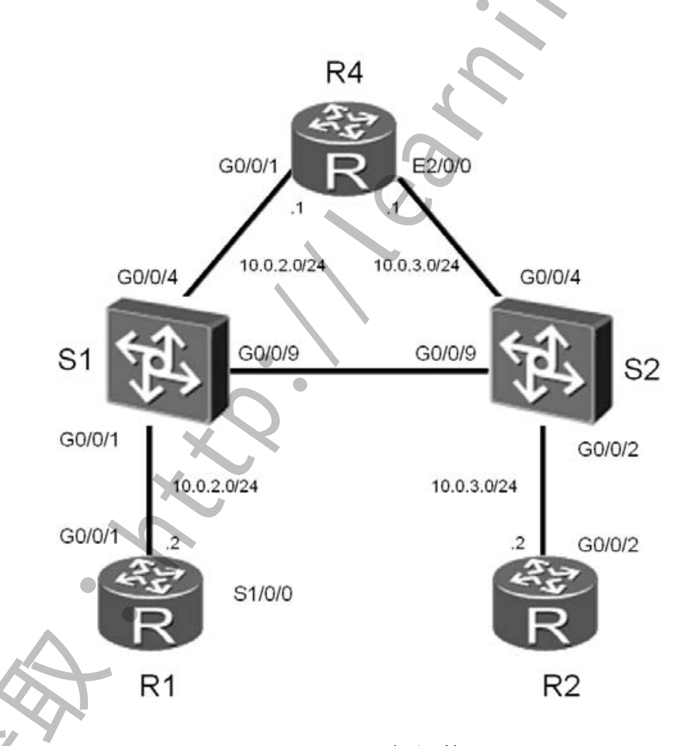



图1-3 VLAN间通信

## 场景

你是公司的网络管理员。现在公司网络是由二台交换机和一台路由器组成的以太网环境。图中R1和R2代表公司不同部门的PC ,分别加入了二个不同的VLAN。

现在需要你实现R1和R2之间的通信。公司最初使用的是多臂路由，后来为了节省成本使用单臂路由。

再后来，因为网络架构的变化，流量更多是在VLAN间传输，所以采用了多层交换。最后，因为为了方便网络管理采用VLAN聚合的技术。

## 学习任务

### 步骤一. 基础配置与 IP 编址

关闭S1的G0/0/10接口避免对实验造成影响。

给所有设备配置IP地址和掩码。

```
<huawei>system-view
Enter system view, return user view with Ctrl+Z.
[huawei]sysname R1
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.2.2 24

<huawei>system-view
Enter system view, return user view with Ctrl+Z.
[huawei]sysname R2
[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]ip address 10.0.3.2 24

<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S1

<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S2

<huawei>system-view
Enter system view, return user view with Ctrl+Z.
[huawei]sysname R4
[R4]interface GigabitEthernet 0/0/1
[R4-GigabitEthernet0/0/1]ip address 10.0.2.1 24
[R4-GigabitEthernet0/0/1]interface Ethernet2/0/0
[R4-Ethernet2/0/0]ip address 10.0.3.1 24
```

使用**ping**命令测试R1与R4接口G0/0/1的地址的连通性。

```
[R1]ping -c 1 10.0.2.1
  PING 10.0.2.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.1: bytes=56 Sequence=1 ttl=255 time=4 ms

  --- 10.0.2.1 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 4/4/4 ms
```

使用**ping**命令测试R2和R4直连接口G0/0/2的连通性。

```
[R2]ping -c 1 10.0.3.1
  PING 10.0.3.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.3.1: bytes=56 Sequence=1 ttl=255 time=3 ms

  --- 10.0.3.1 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms
```

## 步骤二. 多臂路由

R1和R2分别处于不同的VLAN中。

R1的网关使用R4的G0/0/1接口地址，R2的网关使用R4的G0/0/2接口地址。

由R4的多个接口提供VLAN间通信的服务就叫做多臂路由。

在交换机S1和S2上创建VLAN2和VLAN3。

```
[S1]vlan batch 2 3
Info: This operation may take a few seconds. Please wait for a moment...done.

[S2]vlan batch 2 3
Info: This operation may take a few seconds. Please wait for a moment...done.
```

将R1加入VLAN2，R2加入VLAN3，R4的G0/0/1加入VLAN2，G0/0/2加入VLAN3。

```
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port link-type access
[S1-GigabitEthernet0/0/1]port default vlan 2
[S1-GigabitEthernet0/0/1]inter g0/0/4
```

```
[S1-GigabitEthernet0/0/4]port link-type access
[S1-GigabitEthernet0/0/4]port default vlan 2

[S2]interface GigabitEthernet 0/0/2
[S2-GigabitEthernet0/0/2]port link-type access
[S2-GigabitEthernet0/0/2]port default vlan 3
[S2-GigabitEthernet0/0/2]inter g0/0/4
[S2-GigabitEthernet0/0/4]port link-type access
[S2-GigabitEthernet0/0/4]port default vlan 3
```

在R1和R2上配置网关，分别使用所在VLAN的R4接口地址。

```
[R1]ip route-static 0.0.0.0 0 10.0.2.1

[R2]ip route-static 0.0.0.0 0 10.0.3.1
```

使用命令**display vlan**查看并确认配置。

```
[S1]display vlan 2
----------------------------------------------------------------------------
U: Up;        D: Down;        TG: Tagged;        UT: Untagged;
MP: Vlan-mapping;              ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
----------------------------------------------------------------------------
VID  Type    Ports
----------------------------------------------------------------------------
2    common  UT:GE0/0/1(U)      GE0/0/4(U)
VID  Status  Property     MAC-LRN Statistics Description
----------------------------------------------------------------------------
2    enable  default      enable  disable    VLAN 0002

[S2]display vlan 3
----------------------------------------------------------------------------
U: Up;        D: Down;        TG: Tagged;        UT: Untagged;
MP: Vlan-mapping;              ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
----------------------------------------------------------------------------
VID  Type    Ports
----------------------------------------------------------------------------
3    common  UT:GE0/0/2(U)      GE0/0/4(U)
VID  Status  Property     MAC-LRN Statistics Description
----------------------------------------------------------------------------
3    enable  default      enable  disable    VLAN 0003
```

测试R1和R2之间的连通性。

```
[R1]ping -c 1 10.0.3.2
  PING 10.0.3.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.3.2: bytes=56 Sequence=1 ttl=254 time=3 ms

  --- 10.0.3.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms

[R2]ping -c 1 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=254 time=3 ms

  --- 10.0.2.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms
```

## 步骤三. 单臂路由

在R4的一个物理接口上创建二个子接口，VLAN间的通讯通过对应的子接口完成。

这种方法叫做单臂路由。

关闭S2的G0/0/4接口。

```
[S2]interface GigabitEthernet 0/0/4
[S2-GigabitEthernet0/0/4]shutdown
```

将S1和S2的G0/0/9接口加入VLAN 3。

```
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]port link-type access
[S2-GigabitEthernet0/0/9]port default vlan 3

[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]port link-type access
[S1-GigabitEthernet0/0/9]port default vlan 3
```

将S1的G0/0/4接口模式改为Trunk模式，并允许VLAN2和VLAN3通过。

```
[S1]interface GigabitEthernet 0/0/4
[S1-GigabitEthernet0/0/4]port default vlan 1
[S1-GigabitEthernet0/0/4]port link-type trunk
[S1-GigabitEthernet0/0/4]port trunk allow-pass vlan 2 3
```

在R4上为G0/0/1接口创建二个子接口。同时子接口上配置IP地址。并把接口配置成Dot1q终结以太网子接口。

```
[R4]inter GigabitEthernet 0/0/1.2
[R4-GigabitEthernet0/0/1.2]control-vid 20 dot1q-termination
[R4-GigabitEthernet0/0/1.2]dot1q termination vid 2
[R4-GigabitEthernet0/0/1.2]arp broadcast enable
[R4-GigabitEthernet0/0/1.2]ip address 10.0.20.1 24
[R4-GigabitEthernet0/0/1.2]inter GigabitEthernet 0/0/1.3
[R4-GigabitEthernet0/0/1.3]control-vid 30 dot1q-termination
[R4-GigabitEthernet0/0/1.3]dot1q termination vid 3
[R4-GigabitEthernet0/0/1.3]arp broadcast enable
[R4-GigabitEthernet0/0/1.3]ip address 10.0.30.1 24
```

使用**display ip interface brief**命令查看R4上子接口配置信息。

```
[R4]display ip interface brief
*down: administratively down
(l): loopback
(s): spoofing

The number of interface that is UP in Physical is 6
The number of interface that is DOWN in Physical is 4
The number of interface that is UP in Protocol is 3
The number of interface that is DOWN in Protocol is 7

Interface                     IP Address/Mask     Physical   Protocol
Cellular0/0/0                  unassigned          down       down
Cellular0/0/1                  unassigned          down       down
Ethernet2/0/0                  unassigned          down       down
Ethernet2/0/1                  10.0.3.1/24         down       down
GigabitEthernet0/0/0            unassigned          up         down
GigabitEthernet0/0/1            10.0.2.1/24         up         up
GigabitEthernet0/0/1.2          10.0.20.1/24        up         down
GigabitEthernet0/0/1.3          10.0.30.1/24        up         down
NULL0                         unassigned          up         up(s)
Serial1/0/0                    unassigned          up         up
```

更改R1和R2的IP地址和网关。

```
[R1]inter GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.20.2 24
[R1-GigabitEthernet0/0/1]quit
[R1]undo ip route-static 0.0.0.0 0 10.0.2.1
[R1]ip route-static 0.0.0.0 0 10.0.20.1

[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]ip address 10.0.30.2 24
[R2-GigabitEthernet0/0/2]quit
[R2]undo ip route-static 0.0.0.0 0 10.0.3.1
[R2]ip route-static 0.0.0.0 0 10.0.30.1
```

测试R1和R2之间的连通性。

```
[R1]ping -c 1 10.0.30.2
  PING 10.0.30.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.30.2: bytes=56 Sequence=1 ttl=254 time=3 ms

  --- 10.0.30.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms
```

从**ping**命令的输出结果可知，VLAN 2的计算机和VLAN 3的计算机成功通信。

这种方案相对于多臂路由方案可以节省企业购买路由器接口的资金。

但相对的，单臂路由由于所有数据都在同一个接口上传输，随着VLAN数量的增加将会增大这条链路的带宽压力。同时这条链路也成为了企业网络的单点故障，一旦出现问题则整个网络都无法通信。

## 步骤四. 三层交换

三层交换指的是不需要路由器帮助，每个VLAN都有一个Vlanif接口充当路由器接口的角色来实现不同VLAN间通信的方法。

关闭S1的G0/0/4接口。

```
[S1]interface GigabitEthernet 0/0/4
[S1-GigabitEthernet0/0/4]shutdown
```

更改S1的G0/0/9接口和S2的G0/0/9接口的模式为Trunk模式，允许VLAN2和VLAN3通过。

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]port default vlan 1
[S1-GigabitEthernet0/0/9]port link-type trunk
[S1-GigabitEthernet0/0/9]port trunk allow-pass vlan 2 3

[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]port default vlan 1
[S2-GigabitEthernet0/0/9]port link-type trunk
[S2-GigabitEthernet0/0/9]port trunk allow-pass vlan 2 3
```

在S1上创建Vlanif 2接口和Vlanif 3接口，并配置IP地址。

```
[S1]interface Vlanif 2
[S1-Vlanif2]ip address 10.0.20.1 24
[S1]inter Vlanif 3
[S1-Vlanif3]ip address 10.0.30.1 24
```

测试R1和R2之间的连通性。

```
[R1]ping -c 1 10.0.30.2
  PING 10.0.30.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.30.2: bytes=56 Sequence=1 ttl=254 time=2 ms

  --- 10.0.30.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 2/2/2 ms
```

从**ping**命令的输出结果可知，VLAN2 和VLAN 3的计算机通过交换机S1的二个Vlanif接口实现了三层数据通信。

相比单臂路由方案，三层交换更具有扩展性，即使VLAN增加也不会对其性能造成很大影响。

在VLAN间通信占企业大部分流量的网络中能够很好的承担服务压力。

## 步骤五. VLAN 聚合

VLAN聚合和三层交换类似，都可以实现交换机上不同VLAN之间的通信。

相比三层交换的方案它能将所有VLAN都放置在同一个网段中，达到减少IP网段使用和统一网关配置的效果。

在S1和S2上创建VLAN 10、20、100。

```
[S1]vlan batch 10 20 100
Info: This operation may take a few seconds. Please wait for a moment...done.

[S2]vlan batch 10 20 100
Info: This operation may take a few seconds. Please wait for a moment...done.
```

配置S1和S2的G0/0/9接口允许VLAN10、20通过。

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]port trunk allow-pass vlan 10 20

[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]port trunk allow-pass vlan 10 20
```

将S1的G0/0/1接口和S2的G0/0/2接口分别加入VLAN 10和VLAN 20。

```
[S1]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port default vlan 10

[S2]interface GigabitEthernet 0/0/2
[S2-GigabitEthernet0/0/1]port default vlan 20
```

将VLAN100配置为Super-VLAN，并将VLAN 10和VLAN 20作为Sub-VLAN加入VLAN 100。

```
[S1]vlan 100
[S1-vlan100]aggregate-vlan
[S1-vlan100]access-vlan 10 20
```

配置VLAN 100的Vlanif接口，启用ARP Proxy功能。

```
[S1]interface Vlanif 100
[S1-Vlanif100]ip address 10.0.100.1 24
[S1-Vlanif100]arp-proxy inter-sub-vlan-proxy enable
```

更改R1和R2的IP地址，使其与Vlanif 100接口在同一个网段。并且将网关配置为Vlanif 100的接口地址。

```
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.100.2 24
[R1-GigabitEthernet0/0/1]quit
[R1]ip route-static 0.0.0.0 0 10.0.100.1
```

```
[R2]interface GigabitEthernet 0/0/2
[R2-GigabitEthernet0/0/2]ip address 10.0.100.3 24
[R2-GigabitEthernet0/0/2]quit
[R2]ip route-static 0.0.0.0 0 10.0.100.1
```

测试R1、R2和S1的Vlanif100接口之间的连通性。

```
[R1]ping -c 1 10.0.100.1
  PING 10.0.100.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.100.1: bytes=56 Sequence=1 ttl=254 time=3 ms

  --- 10.0.100.1 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms

[R1]ping -c 1 10.0.100.3
  PING 10.0.100.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.100.3: bytes=56 Sequence=1 ttl=254 time=2 ms

  --- 10.0.100.3 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 2/2/2 ms

[R2]pin -c 1 10.0.100.1
  PING 10.0.100.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.100.1: bytes=56 Sequence=1 ttl=254 time=3 ms

  --- 10.0.100.1 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 3/3/3 ms
```

从**ping**命令的输出结果可知，R1、R2和S1的Vlanif 100接口可以互相通信。相比三层交换方案，VLAN聚合方案能够实现不同VLAN都使用相同的网关通信的功能，有效的减少IP地址的浪费和提高管理效率。但相对的，相同网段的计算机之间互访都依靠同一个Vlanif接口，也使这个接口的压力增大。

## 附加实验：思考并验证

多臂路由、单臂路由、VLAN间通信和VLAN聚合这四种方案各自的特点、优缺点和适用场景是怎么样的？

## 最终设备配置

```
[S1]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 2 to 3 10 20 100
#
vlan 100
 aggregate-vlan
 access-vlan 10 20
#
interface Vlanif2
 ip address 10.0.20.1 255.255.255.0
#
interface Vlanif3
 ip address 10.0.30.1 255.255.255.0
#
interface Vlanif100
 ip address 10.0.100.1 255.255.255.0
 arp-proxy inter-sub-vlan-proxy enable
#
interface GigabitEthernet0/0/1
 port link-type access
 port default vlan 10
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/4
 shutdown
 port link-type trunk
 port trunk allow-pass vlan 2 to 3
 undo ntdp enable
```

```
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/9
 port link-type trunk
 port trunk allow-pass vlan 2 to 3 10 20
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/10
 shutdown
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
Return

[S2]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 vlan batch 2 to 3 10 20 100
#
interface GigabitEthernet0/0/2
 port link-type access
 port default vlan 20
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/4
 shutdown
 port link-type access
 port default vlan 3
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface GigabitEthernet0/0/9
 port link-type trunk
 port trunk allow-pass vlan 2 to 3 10 20
```

```
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
return

[R4]display current-configuration
[V200R001C00SPC500]
#
 sysname R4
#
interface GigabitEthernet0/0/1
 ip address 10.0.2.1 255.255.255.0
#
interface GigabitEthernet0/0/1.2
 control-vid 20 dot1q-termination
 dot1q termination vid 2
 ip address 10.0.20.1 255.255.255.0
 arp broadcast enable
#
interface GigabitEthernet0/0/1.3
 control-vid 30 dot1q-termination
 dot1q termination vid 3
 ip address 10.0.30.1 255.255.255.0
 arp broadcast enable
#
interface GigabitEthernet0/0/0
ip address 10.0.3.1 255.255.255.0
#
return
```

# 第二章 STP与SEP配置

## 实验 2-1 静态路由及默认路由

### 学习目的

- 了解STP、RSTP与MSTP的差异
- 掌握修改网桥优先级影响根网桥选举的方法
- 掌握修改端口优先级影响根端口与指定端口选举的方法
- 掌握配置RSTP的方法以及STP与RSTP的相互兼容问题
- 掌握配置MSTP实现不同VLAN负载均衡的方法

### 拓扑图

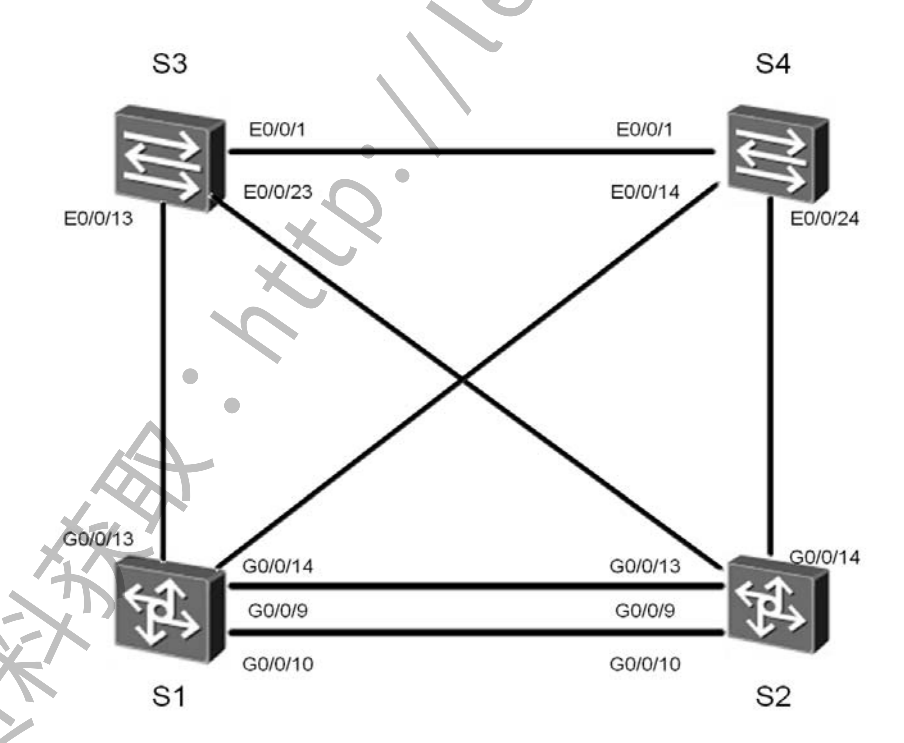



图2-1 STP、RSTP与MSTP实验拓扑图

## 场景

你是公司的网络管理员。公司的网络采用了备份网络，为避免环路问题，使用STP来进行环路控制。接口在STP的收敛时，所需时间较长，为了加快网络的收敛速度，可以配置RSTP来实现。所有的VLAN共享一棵STP生成树，为了实现VLAN间数据流量的负载均衡，可以配置MSTP来实现。

## 学习任务

## 步骤一.　STP 配置及验证

如果设备默认生成树没有开启，使用以下命令开启。

```
[S1]stp enable

[S2]stp enable

[S3]stp enable

[S4]stp enable
```

配置使用传统生成树。

```
[S1]stp mode stp

[S2]stp mode stp

[S3]stp mode stp

[S4]stp mode stp
```

查看STP状态信息。

```
[S1]display stp
-------[CIST Global Info][Mode STP]-------
CIST Bridge         :32768.4c1f-cc45-aadc
Bridge Times        :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC      :32768.4c1f-cc45-aac1 / 20000
CIST RegRoot/IRPC   :32768.4c1f-cc45-aadc / 0
CIST RootPortId     :128.9
BPDU-Protection     :Disabled
TC or TCN received  :36
```

```
TC count per hello  :2
STP Converge Mode   :Normal
Share region-configuration :Enabled
Time since last TC  :0 days 0h:0m:1s
……output omit……

[S2]display stp
-------[CIST Global Info][Mode STP]-------
CIST Bridge         :32768.4c1f-cc45-aac1
Bridge Times        :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC      :32768.4c1f-cc45-aac1 / 0
CIST RegRoot/IRPC   :32768.4c1f-cc45-aac1 / 0
CIST RootPortId     :0.0
BPDU-Protection     :Disabled
TC or TCN received  :20
TC count per hello  :0
STP Converge Mode   :Normal
Share region-configuration :Enabled
Time since last TC  :0 days 0h:1m:4s
……output omit……

[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9         ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/10        ALTE  DISCARDING      NONE
   0    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/14        DESI  FORWARDING      NONE

[S2]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9         DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/23        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/24        DESI  FORWARDING      NONE
```

S2为根网桥，所有端口都为指定端口。

实际使用中，由于交换机MAC地址的不可确定性，实际的实验结果可能与如上结果有差异。

## 步骤二. 根桥选举控制

配置S1为主根网桥，S2为备份根网桥。

```
[S1]stp root primary

[S2]stp root secondary
```

查看STP配置信息。

```
[S1]display stp
-------[CIST Global Info][Mode STP]-------
CIST Bridge         :0    .4c1f-cc45-aadc
Bridge Times        :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC      :0    .4c1f-cc45-aadc / 0
CIST RegRoot/IRPC   :0    .4c1f-cc45-aadc / 0
CIST RootPortId     :0.0
BPDU-Protection     :Disabled
CIST Root Type      :Primary root
TC or TCN received  :67
TC count per hello  :0
STP Converge Mode   :Normal
Share region-configuration :Enabled
Time since last TC  :0 days 0h:0m:15s
……output omit……

[S2]display stp
-------[CIST Global Info][Mode STP]-------
CIST Bridge         :4096 .4c1f-cc45-aac1
Bridge Times        :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC      :0    .4c1f-cc45-aadc / 20000
CIST RegRoot/IRPC   :4096 .4c1f-cc45-aac1 / 0
CIST RootPortId     :128.9
BPDU-Protection     :Disabled
CIST Root Type      :Secondary root
TC or TCN received  :26
TC count per hello  :0
STP Converge Mode   :Normal
Share region-configuration :Enabled
Time since last TC  :0 days 0h:0m:1s
……output omit……
```

S1为主根网桥，S2为备份根网桥。

桥优先级数值越小的优先级越高，将S1的桥优先级修改为8192，将S2的桥优先级修改为4096。

```
[S1]undo stp root
[S1]stp priority 8192
```

```
[S2]undo stp root
[S2]stp priority 4096
```

查看STP信息。

```
[S1]display stp
-------[CIST Global Info][Mode STP]-------
CIST Bridge         :8192 .4c1f-cc45-aadc
Bridge Times        :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC      :4096 .4c1f-cc45-aac1 / 20000
CIST RegRoot/IRPC   :8192 .4c1f-cc45-aadc / 0
CIST RootPortId     :128.9
BPDU-Protection     :Disabled
TC or TCN received  :79
TC count per hello  :1
STP Converge Mode   :Normal
Share region-configuration :Enabled
Time since last TC  :0 days 0h:0m:0s
……output omit……

[S2]display stp
-------[CIST Global Info][Mode STP]-------
CIST Bridge         :4096 .4c1f-cc45-aac1
Bridge Times        :Hello 2s MaxAge 20s FwDly 15s MaxHop 20
CIST Root/ERPC      :4096 .4c1f-cc45-aac1 / 0
CIST RegRoot/IRPC   :4096 .4c1f-cc45-aac1 / 0
CIST RootPortId     :0.0
BPDU-Protection     :Disabled
TC or TCN received  :88
TC count per hello  :0
STP Converge Mode   :Normal
Share region-configuration :Enabled
Time since last TC  :0 days 0h:0m:9s
……output omit……
```

S1优先级为8192，S2优先级为4096，S2成为根网桥。

## 步骤三. 根端口选举控制

在S1上查看当前端口角色信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
```

```
 0    GigabitEthernet0/0/9        ROOT  FORWARDING      NONE
 0    GigabitEthernet0/0/10       ALTE  DISCARDING      NONE
 0    GigabitEthernet0/0/13       DESI  FORWARDING      NONE
 0    GigabitEthernet0/0/14       DESI  FORWARDING      NONE
```

S1的GigabitEthernet0/0/9为根端口。

端口优先级默认值为128，数值越大优先级越小。

S1与S2通过G0/0/9与G0/0/10接口互联。

将S2的端口G0/0/9端口优先级设置为32，G0/0/10端口优先级设置为16。

```
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]stp port priority 32
[S2-GigabitEthernet0/0/9]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]stp port priority 16
```

提示：此处是修改S2的端口优先级，而不是修改S1的端口优先级。

在S1上查看当前端口角色信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
 0    GigabitEthernet0/0/9        ALTE  DISCARDING      NONE
 0    GigabitEthernet0/0/10       ROOT  DISCARDING      NONE
 0    GigabitEthernet0/0/13       DESI  FORWARDING      NONE
 0    GigabitEthernet0/0/14       DESI  FORWARDING      NONE
```

S1的GigabitEthernet0/0/10成为根端口。

## 步骤四.　指定端口选举控制

查看S3和S4直连接口状态。

```
 [S3]display stp interface Ethernet 0/0/1
----[CIST][Port1(Ethernet0/0/1)][DISCARDING]----
 Port Protocol          :Enabled
 Port Role             :Alternate Port
 Port Priority          :128
 Port Cost(Dot1T )    :Config=auto / Active=199999
 Designated Bridge/Port    :32768.5489-98ec-f00a / 128.1
 Port Edged            :Config=default / Active=disabled
 Point-to-point         :Config=auto / Active=true
 Transit Limit          :147 packets/hello-time
 Protection Type        :None
```

```
 Port STP Mode      :STP
 Port Protocol Type  :Config=auto / Active=dot1s
 PortTimes          :Hello 2s MaxAge 20s FwDly 15s RemHop 0
 TC or TCN send      :17
 TC or TCN received  :52
 BPDU Sent          :172
        TCN: 0, Config: 172, RST: 0, MST: 0
 BPDU Received      :206
        TCN: 0, Config: 206, RST: 0, MST: 0

[S4]display stp interface Ethernet 0/0/24
----[CIST][Port24(Ethernet0/0/24)][DISCARDING]----
 Port Protocol      :Enabled
 Port Role          :Designated Port
 Port Priority      :128
 Port Cost(Dot1T )   :Config=auto / Active=199999
 Designated Bridge/Port   :32768.5489-98ec-f00a / 128.1
 Port Edged         :Config=default / Active=disabled
 Point-to-point      :Config=auto / Active=true
 Transit Limit      :147 packets/hello-time
 Protection Type     :None
 Port STP Mode      :STP
 Port Protocol Type  :Config=auto / Active=dot1s
 PortTimes          :Hello 2s MaxAge 20s FwDly 15s RemHop 20
 TC or TCN send      :37
 TC or TCN received  :17
 BPDU Sent          :181
        TCN: 0, Config: 181, RST: 0, MST: 0
 BPDU Received      :172
        TCN: 0, Config: 172, RST: 0, MST: 0
```

S3的Ethernet 0/0/1为替代端口。S4的Ethernet 0/0/1是指定端口。修改S4端口E0/0/24路径开销为2000000。

```
[S4-Ethernet0/0/24]stp cost 2000000
```

查看当前端口角色信息。

```
[S3]display stp interface Ethernet 0/0/1
----[CIST][Port1(Ethernet0/0/1)][FORWARDING]----
 Port Protocol      :Enabled
 Port Role          :Designated Port
 Port Priority      :128
 Port Cost(Dot1T )   :Config=auto / Active=199999
```

```
 Designated Bridge/Port   :32768.5489-98ec-f022 / 128.1
 Port Edged          :Config=default / Active=disabled
 Point-to-point      :Config=auto / Active=true
 Transit Limit       :147 packets/hello-time
 Protection Type     :None
 Port STP Mode       :STP
 Port Protocol Type  :Config=auto / Active=dot1s
 PortTimes          :Hello 2s MaxAge 20s FwDly 15s RemHop 20
 TC or TCN send      :52
 TC or TCN received  :52
 BPDU Sent          :284
        TCN: 0, Config: 284, RST: 0, MST: 0
 BPDU Received       :380
        TCN: 0, Config: 380, RST: 0, MST: 0

[S4]display stp interface Ethernet 0/0/24
----[CIST][Port24(Ethernet0/0/24)][DISCARDING]----
 Port Protocol       :Enabled
 Port Role          :Alternate Port
 Port Priority       :128
 Port Cost(Dot1T )   :Config=2000000 / Active=2000000
 Designated Bridge/Port   :4096.4c1f-cc45-aac1 / 128.24
 Port Edged          :Config=default / Active=disabled
 Point-to-point      :Config=auto / Active=true
 Transit Limit       :147 packets/hello-time
 Protection Type     :None
 Port STP Mode       :STP
 Port Protocol Type  :Config=auto / Active=dot1s
 PortTimes          :Hello 2s MaxAge 20s FwDly 15s RemHop 0
 TC or TCN send      :7
 TC or TCN received  :162
 BPDU Sent          :8
        TCN: 7, Config: 1, RST: 0, MST: 0
 BPDU Received       :1891
        TCN: 0, Config: 1891, RST: 0, MST: 0
```

S3的Ethernet 0/0/1是指定端口。S4的Ethernet 0/0/1为替代端口。

## 步骤五. RSTP 配置及验证

配置S1和S2的VLANIF 1接口地址。测试S1到S2的连通性。

```
[S1]interface Vlanif 1
```

```
[S1-Vlanif1]ip address 10.0.1.1 24

[S2]interface Vlanif 1
[S2-Vlanif1]ip address 10.0.1.2 24

[S1]ping 10.0.1.2
  PING 10.0.1.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.2: bytes=56 Sequence=1 ttl=255 time=9 ms
    Reply from 10.0.1.2: bytes=56 Sequence=2 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=3 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=4 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=5 ttl=254 time=1 ms

  --- 10.0.1.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 1/2/9 ms
```

查看S1端口角色信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9         ALTE  DISCARDING     NONE
   0    GigabitEthernet0/0/10        ROOT  FORWARDING     NONE
   0    GigabitEthernet0/0/13        DESI  FORWARDING     NONE
   0    GigabitEthernet0/0/14        DESI  FORWARDING     NONE
```

S1的GigabitEthernet0/0/10为根端口，用ping测试S1到S2的连通性20次。

提示：S1执行ping操作之后立刻关闭S2的GigabitEthernet 0/0/10接口。

```
 [S1]ping -c 20 10.0.1.2
  PING 10.0.1.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.2: bytes=56 Sequence=1 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=2 ttl=254 time=1 ms
Dec 21 2011 16:20:44-05:13 S1 %%01IFNET/4/IF_STATE(l)[5]:Interface
GigabitEthernet0/0/10 has turned into DOWN state.
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
```

```
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Reply from 10.0.1.2: bytes=56 Sequence=18 ttl=255 time=15 ms
    Reply from 10.0.1.2: bytes=56 Sequence=19 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=20 ttl=254 time=1 ms

  --- 10.0.1.2 ping statistics ---
    20 packet(s) transmitted
    5 packet(s) received
    75.00% packet loss
    round-trip min/avg/max = 1/3/15 ms

[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]shutdown
```

查看S1端口角色信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9        ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/13       DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/14       DESI  FORWARDING      NONE
```

S1的GigabitEthernet0/0/9接口成为根端口，端口进入FORWARDING状态，15个包超时，网络收敛时间为30秒。

恢复S2的GigabitEthernet 0/0/10接口。

```
[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]undo shutdown
```

配置快速生成树。

```
[S1]stp mode rstp

[S2]stp mode rstp

[S3]stp mode rstp
```

```
[S4]stp mode rstp
```

查看S1端口角色信息。

```
[S1]display stp brief
 MSTID      Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9        ALTE  DISCARDING      NONE
   0    GigabitEthernet0/0/10       ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/13       DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/14       DESI  FORWARDING      NONE
```

S1的GigabitEthernet0/0/10为根端口，用**ping**测试S1到S2的连通性20次。

提示：S1上执行ping之后立刻关闭S2的GigabitEthernet 0/0/10。

```
[S1]ping -c 20 10.0.1.2
  PING 10.0.1.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.2: bytes=56 Sequence=1 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=2 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=3 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=4 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=5 ttl=254 time=1 ms
Dec 21 2011 16:37:10-05:13 S1 %%01IFNET/4/IF_STATE(l)[7]:Interface 
GigabitEthernet0/0/10 has turned into DOWN state.
    Request time out
    Reply from 10.0.1.2: bytes=56 Sequence=7 ttl=255 time=10 ms
    Reply from 10.0.1.2: bytes=56 Sequence=8 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=9 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=10 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=11 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=12 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=13 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=14 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=15 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=16 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=17 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=18 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=19 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=20 ttl=254 time=1 ms

  --- 10.0.1.2 ping statistics ---
    20 packet(s) transmitted
    19 packet(s) received
    5.00% packet loss
```

```
   round-trip min/avg/max = 1/1/10 ms

[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]shutdown
```

查看S1端口角色信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9        ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/13       DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/14       DESI  FORWARDING      NONE
```

S1的GigabitEthernet0/0/9接口成为根端口，进入Forwarding状态。1个包超时，网络收敛时间为2秒。

开启S2的GigabitEthernet 0/0/10接口。

```
[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]undo shutdown
```

## 步骤六.　　RSTP 与 STP 的兼容

配置S1为STP生成树，其他配置保持不变。

```
[S1]stp mode stp
```

查看S1端口角色信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9        ALTE  DISCARDING      NONE
   0    GigabitEthernet0/0/10       ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/13       DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/14       DESI  FORWARDING      NONE
```

S1的GigabitEthernet0/0/10为根端口，用ping测试S1到S2的连通性20次。

提示：S1上执行ping之后立刻关闭S2的GigabitEthernet 0/0/10。

```
 [S1]ping -c 20 10.0.1.2
  PING 10.0.1.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.2: bytes=56 Sequence=1 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=2 ttl=254 time=1 ms
Dec 21 2011 16:20:44-05:13 S1 %%01IFNET/4/IF_STATE(l)[5]:Interface
```

```
GigabitEthernet0/0/10 has turned into DOWN state.
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out
    Reply from 10.0.1.2: bytes=56 Sequence=18 ttl=255 time=15 ms
    Reply from 10.0.1.2: bytes=56 Sequence=19 ttl=254 time=1 ms
    Reply from 10.0.1.2: bytes=56 Sequence=20 ttl=254 time=1 ms

  --- 10.0.1.2 ping statistics ---
    20 packet(s) transmitted
    5 packet(s) received
    75.00% packet loss
    round-trip min/avg/max = 1/3/15 ms

[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]shutdown
```

查看S1端口角色信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9         ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/14        DESI  FORWARDING      NONE
```

S1的GigabitEthernet0/0/9接口成为根端口，进入Forwarding状态。15个包超时，网络收敛时间为30秒。

RSTP兼容STP，但收敛方式以STP模式运行。

恢复S2的GigabitEthernet 0/0/10接口。

```
[S2]interface GigabitEthernet 0/0/10
```

```
[S2-GigabitEthernet0/0/10]undo shutdown
```

## 步骤七. MSTP 的配置与验证

创建VLAN 2到20，并将相应的接口加入到VLAN中。

```
[S1]vlan batch 2 to 20
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]port link-type trunk
[S1-GigabitEthernet0/0/9]port trunk allow-pass vlan 1 TO 20
[S1-GigabitEthernet0/0/9]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]port link-type trunk
[S1-GigabitEthernet0/0/10]port trunk allow-pass vlan 1 TO 20
[S1-GigabitEthernet0/0/10]interface GigabitEthernet 0/0/13
[S1-GigabitEthernet0/0/13]port link-type trunk
[S1-GigabitEthernet0/0/13]port trunk allow-pass vlan 1 TO 20
[S1-GigabitEthernet0/0/13]interface GigabitEthernet 0/0/14
[S1-GigabitEthernet0/0/14]port link-type trunk
[S1-GigabitEthernet0/0/14]port trunk allow-pass vlan 1 TO 20

[S2]vlan batch 1 to 20
Info: This operation may take a few seconds. Please wait for a moment...done.
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]port link-type trunk
[S2-GigabitEthernet0/0/9]port trunk allow-pass vlan 1 TO 20
[S2-GigabitEthernet0/0/9]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]port link-type trunk
[S2-GigabitEthernet0/0/10]port trunk allow-pass vlan 1 TO 20
[S2-GigabitEthernet0/0/10]interface GigabitEthernet 0/0/23
[S2-GigabitEthernet0/0/23]port link-type trunk
[S2-GigabitEthernet0/0/23]port trunk allow-pass vlan 1 TO 20
[S2-GigabitEthernet0/0/23]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]port link-type trunk
[S2-GigabitEthernet0/0/24]port trunk allow-pass vlan 1 TO 20

[S3]vlan batch 1 to 20
Info: This operation may take a few seconds. Please wait for a moment...done.
[S3]interface Ethernet0/0/1
[S3-Ethernet0/0/1]port link-type trunk
[S3-Ethernet0/0/1]port trunk allow-pass vlan 1 TO 20
[S3-Ethernet0/0/1]interface Ethernet0/0/13
```

```
[S3-Ethernet0/0/13]port link-type trunk
[S3-Ethernet0/0/13]port trunk allow-pass vlan 1 TO 20
[S3-Ethernet0/0/13]interface Ethernet0/0/23
[S3-Ethernet0/0/23]port link-type trunk
[S3-Ethernet0/0/23]port trunk allow-pass vlan 1 TO 20

[S4]vlan batch 1 to 20
Info: This operation may take a few seconds. Please wait for a moment...done.
[S4]interface Ethernet0/0/1
[S4-Ethernet0/0/1]port link-type trunk
[S4-Ethernet0/0/1]port trunk allow-pass vlan 1 TO 20
[S4-Ethernet0/0/1]interface Ethernet0/0/14
[S4-Ethernet0/0/14]port link-type trunk
[S4-Ethernet0/0/14]port trunk allow-pass vlan 1 TO 20
[S4-Ethernet0/0/14]interface Ethernet0/0/24
[S4-Ethernet0/0/24]port link-type trunk
[S4-Ethernet0/0/24]port trunk allow-pass vlan 1 TO 20
```

配置MSTP。

定义VLAN1-10属于INSTANCE 1，VLAN11-20属于INSTANCE 2。

```
[S1]stp mode mstp
[S1]stp region-configuration
[S1-mst-region]region-name RG1
[S1-mst-region]instance 1 vlan 1 TO 10
[S1-mst-region]instance 2 vlan 11 to 20
[S1-mst-region]active region-configuration
Info: This operation may take a few seconds. Please wait for a moment....done.

[S2]stp mode mstp
[S2]stp region-configuration
[S2-mst-region]region-name RG1
[S2-mst-region]instance 1 vlan 1 TO 10
[S2-mst-region]instance 2 vlan 11 to 20
[S2-mst-region]active region-configuration
Info: This operation may take a few seconds. Please wait for a moment....done.

[S3]STP mode mstp
Info: This operation may take a few seconds. Please wait for a moment.....done.
[S3]stp region-configuration
[S3-mst-region]region-name RG1
[S3-mst-region]instance 1 vlan 1 to 10
[S3-mst-region]instance 2 vlan 11 to 20
```

```
[S4]STP mode mstp
Info: This operation may take a few seconds. Please wait for a moment.....done.
[S4]stp region-configuration
[S4-mst-region]region-name RG1
[S4-mst-region]instance 1 vlan 1 to 10
[S4-mst-region]instance 2 vlan 11 to 20
```

查看MSTP实例和VLAN的映射关系。

```
[S1]display stp region-configuration
 Oper configuration
   Format selector    :0
   Region name       :RG1
   Revision level     :0
   Instance   VLANs Mapped
     0      21 to 4094
     1       1 to 10
     2      11 to 20
```

配置S1在实例1中的优先级为4096，在实例2中的优先级为8192。

配置S2在实例2中的优先级为4096，在实例1中的优先级为8192。

```
[S1]stp instance 1 priority 4096
[S1]stp instance 2 priority 8192

[S2]stp instance 2 priority 4096
[S2]stp instance 1 priority 8192
```

查看实例1和实例2的状态信息。

```
[S1]display stp instance 1
-------[MSTI 1 Global Info]-------
MSTI Bridge ID      :4096.4c1f-cc45-aadc
MSTI RegRoot/IRPC    :4096.4c1f-cc45-aadc / 0
MSTI RootPortId     :0.0
Master Bridge       :4096.4c1f-cc45-aac1
Cost to Master      :20000
TC received        :20
TC count per hello  :0

[S2]display stp instance 2
-------[MSTI 2 Global Info]-------
MSTI Bridge ID      :4096.4c1f-cc45-aac1
```

```
MSTI RegRoot/IRPC   :4096.4c1f-cc45-aac1 / 0
MSTI RootPortId     :0.0
Master Bridge       :4096.4c1f-cc45-aac1
Cost to Master      :0
TC received         :16
TC count per hello  :0
```

S1为实例1的根桥，S2为实例2的根桥。

查看MSTP实例1端口角色。

```
[S1]display stp instance 1 brief
 MSTID  Port                        Role  STP State     Protection
   1    GigabitEthernet0/0/9         DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/14        DESI  FORWARDING      NONE

[S2]display stp instance 1 brief
 MSTID  Port                        Role  STP State     Protection
   1    GigabitEthernet0/0/9         ROOT  FORWARDING      NONE
   1    GigabitEthernet0/0/10        ALTE  DISCARDING      NONE
   1    GigabitEthernet0/0/23        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/24        DESI  FORWARDING      NONE

[S3]display stp instance 1 brief
 MSTID  Port                        Role  STP State     Protection
   1    Ethernet0/0/1              ALTE  DISCARDING      NONE
   1    Ethernet0/0/13             ROOT  FORWARDING      NONE
   1    Ethernet0/0/23             ALTE  DISCARDING      NONE

[S4]display stp instance 1 brief
 MSTID  Port                        Role  STP State     Protection
   1    Ethernet0/0/1              DESI  FORWARDING      NONE
   1    Ethernet0/0/14             ROOT  FORWARDING      NONE
   1    Ethernet0/0/24             ALTE  DISCARDING      NONE
```

实例1中S1为根网桥，S3的VLAN 1到VLAN10的用户经过Ethernet0/0/13接口和S1、S2、S4的VLAN 1到VLAN10的用户通讯。

查看MSTP实例2端口角色。

```
[S1]display stp instance 2 brief
 MSTID  Port                        Role  STP State     Protection
   2    GigabitEthernet0/0/9         ROOT  FORWARDING      NONE
```

```
  2    GigabitEthernet0/0/10      ALTE  DISCARDING     NONE
  2    GigabitEthernet0/0/13      DESI  FORWARDING     NONE

[S2]display stp instance 2 brief
 MSTID  Port                        Role  STP State     Protection
  2    GigabitEthernet0/0/9        DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/10       DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/23       DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/24       DESI  FORWARDING     NONE

[S3]display stp instance 2 brief
 MSTID  Port                        Role  STP State     Protection
  2    Ethernet0/0/1               ALTE  DISCARDING     NONE
  2    Ethernet0/0/13              ALTE  DISCARDING     NONE
  2    Ethernet0/0/23              ROOT  FORWARDING     NONE

[S4]display stp instance 2 brief
 MSTID  Port                        Role  STP State     Protection
  2    Ethernet0/0/1               DESI  FORWARDING     NONE
  2    Ethernet0/0/14              DESI  FORWARDING     NONE
  2    Ethernet0/0/24              ROOT  FORWARDING     NONE
```

实例2中S2为根网桥，S3的VLAN 11到VLAN 20经过Ethernet0/0/23和S1、S2、S4的VLAN 11到VLAN 20通讯。

## 附加实验：思考并验证

MSTP如何在多个区域实现不同VLAN数据传输的均衡？

RSTP快速转发的原因是什么？

## 最终设备配置

```
[S1]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
vlan batch 2 to 20
#
```

```
 stp instance 0 priority 8192
 stp instance 1 priority 4096
 stp instance 2 priority 8192
#
 stp region-configuration
  region-name RG1
  instance 1 vlan 1 to 10
  instance 2 vlan 11 to 20
  active region-configuration
#
interface Vlanif1
 ip address 10.0.1.1 255.255.255.0
#
interface GigabitEthernet0/0/9
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
interface GigabitEthernet0/0/10
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
interface GigabitEthernet0/0/13
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
Return

[S2]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 vlan batch 2 to 20
#
stp instance 0 priority 4096
stp instance 1 priority 8192
stp instance 2 priority 4096
#
 stp region-configuration
  region-name RG1
  instance 1 vlan 1 to 10
  instance 2 vlan 11 to 20
  active region-configuration
```

```
#
interface Vlanif1
 ip address 10.0.1.2 255.255.255.0
#
interface GigabitEthernet0/0/9
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
 stp instance 0 port priority 32
#
interface GigabitEthernet0/0/10
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
 stp instance 0 port priority 16
#
interface GigabitEthernet0/0/23
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
interface GigabitEthernet0/0/24
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
Return

[S3]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S3
#
vlan batch 2 to 20
#
stp region-configuration
  region-name RG1
  instance 1 vlan 1 to 10
  instance 2 vlan 11 to 20
  active region-configuration
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
interface Ethernet0/0/13
 port link-type trunk
```

```
 port trunk allow-pass vlan 2 to 20
#
interface Ethernet0/0/23
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
Return

[S4]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S4
#
 vlan batch 2 to 20
#
 stp region-configuration
  region-name RG1
  instance 1 vlan 1 to 10
  instance 2 vlan 11 to 20
  active region-configuration
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
interface Ethernet0/0/14
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
#
interface Ethernet0/0/23
#
interface Ethernet0/0/24
 port link-type trunk
 port trunk allow-pass vlan 2 to 20
 stp instance 0 cost 2000000
#
Return
```

## 实验 2-2 MSTP 多区域与 STP 的兼容（选做）

### 学习目的

- 掌握MSTP多实例以及多区域的配置方法
- 掌握实现MSTP与相STP兼容的配置方法
- 掌握MSTP边缘端口保护、指定端口保护、环路保护、TC-BPDU保护的配置方法

### 拓扑图

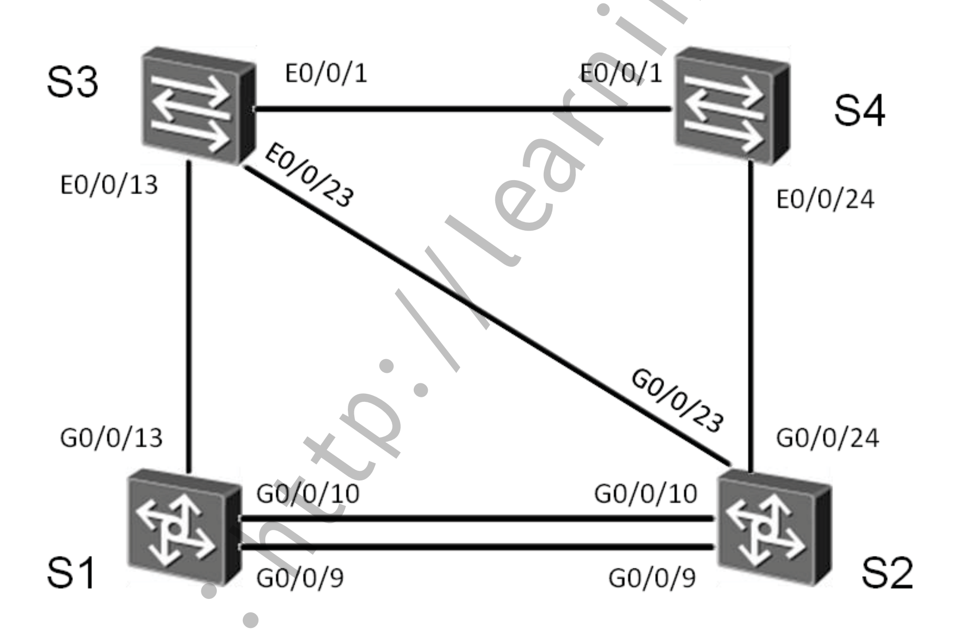



图2-2 MSTP多区域与STP的兼容

### 场景

你是公司的网络管理员。在公司的二层网络架构中，为了克服单个生成树的会造成部分VLAN路径不通及次优路径等种种弊端，并且实现流量的分担。在网络中部署MSTP协议，并能实现与传统单生成树之间的相互兼容。

## 学习任务

### 步骤一. 基本配置

在本实验之前，需要关闭一些不使用的接口。

```
<S1>system-view
Enter system view, return user view with Ctrl+Z.
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]shutdown

<S3>system-view
Enter system view, return user view with Ctrl+Z.
[S3]int Ethernet 0/0/23
[S3-Ethernet0/0/23]shutdown

<S4>system-view
Enter system view, return user view with Ctrl+Z.
[S4]interface Ethernet 0/0/14
[S4-Ethernet0/0/14]shutdown
```

所有交换机上都创建VLAN 3,4,5,6,7,8，

```
[S1]vlan batch 3 to 8

[S2]vlan batch 3 to 8

[S3]vlan batch 3 to 8

[S4]vlan batch 3 to 8
```

查看创建的VLAN，

```
[S1]display vlan
* : management-vlan
---------------------
The total number of vlans is : 7
VLAN ID Type         Status   MAC Learning Broadcast/Multicast/Unicast Property
----------------------------------------------------------------------------
1      common       enable   enable       forward   forward   forward default
3      common       enable   enable       forward   forward   forward default
4      common       enable   enable       forward   forward   forward default
5      common       enable   enable       forward   forward   forward default
```

```
6       common      enable   enable      forward   forward   forward default
7       common      enable   enable      forward   forward   forward default
8       common      enable   enable      forward   forward   forward default

[S2]display vlan
* : management-vlan
---------------------
The total number of vlans is : 7
VLAN ID Type        Status   MAC Learning Broadcast/Multicast/Unicast Property
----------------------------------------------------------------------------
1       common      enable   enable      forward   forward   forward default
3       common      enable   enable      forward   forward   forward default
4       common      enable   enable      forward   forward   forward default
5       common      enable   enable      forward   forward   forward default
6       common      enable   enable      forward   forward   forward default
7       common      enable   enable      forward   forward   forward default
8       common      enable   enable      forward   forward   forward default

[S3]display vlan
* : management-vlan
---------------------
The total number of vlans is : 7
VLAN ID Type        Status   MAC Learning Broadcast/Multicast/Unicast Property
----------------------------------------------------------------------------
1       common      enable   enable      forward   forward   forward default
3       common      enable   enable      forward   forward   forward default
4       common      enable   enable      forward   forward   forward default
5       common      enable   enable      forward   forward   forward default
6       common      enable   enable      forward   forward   forward default
7       common      enable   enable      forward   forward   forward default
8       common      enable   enable      forward   forward   forward default

[S4]display vlan
* : management-vlan
---------------------
The total number of vlans is : 7
VLAN ID Type        Status   MAC Learning Broadcast/Multicast/Unicast Property
----------------------------------------------------------------------------
1       common      enable   enable      forward   forward   forward default
3       common      enable   enable      forward   forward   forward default
4       common      enable   enable      forward   forward   forward default
5       common      enable   enable      forward   forward   forward default
6       common      enable   enable      forward   forward   forward default
```

```
7       common       enable   enable      forward   forward   forward default
8       common       enable   enable      forward   forward   forward default
```

设置所有交换机之间链路类型全部为Trunk链路，接收BPDU，并且允许所有VLAN通过。注意S2与S3之间的直连链路此时不做任何配置。

```
[S1]interface GigabitEthernet 0/0/13
[S1-GigabitEthernet0/0/13]port link-type trunk
[S1-GigabitEthernet0/0/13]port trunk allow-pass vlan all
[S1-GigabitEthernet0/0/13]bpdu enable
[S1-GigabitEthernet0/0/13]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]port link-type trunk
[S1-GigabitEthernet0/0/10]port trunk allow-pass vlan all
[S1-GigabitEthernet0/0/10]bpdu enable

[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]port link-type trunk
[S2-GigabitEthernet0/0/24]port trunk allow-pass vlan all
[S2-GigabitEthernet0/0/24]bpdu enable
[S2-GigabitEthernet0/0/24]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]port link-type trunk
[S2-GigabitEthernet0/0/10]port trunk allow-pass vlan all
[S2-GigabitEthernet0/0/10]bpdu enable

[S3]interface  Ethernet0/0/1
[S3-Ethernet0/0/1]port link-type trunk
[S3-Ethernet0/0/1]port trunk allow-pass vlan all
[S3-Ethernet0/0/1]bpdu enable
[S3-Ethernet0/0/1]interface Ethernet0/0/13
[S3-Ethernet0/0/13]port link-type trunk
[S3-Ethernet0/0/13]port trunk allow-pass vlan all
[S3-Ethernet0/0/13]bpdu enable

[S4]interface  Ethernet0/0/1
[S4-Ethernet0/0/1]port link-type trunk
[S4-Ethernet0/0/1]port trunk allow-pass vlan all
[S4-Ethernet0/0/1]bpdu enable
[S4-Ethernet0/0/1]interface Ethernet0/0/24
[S4-Ethernet0/0/24]port link-type trunk
[S4-Ethernet0/0/24]port trunk allow-pass vlan all
[S4-Ethernet0/0/24]bpdu enable
```



## 步骤二. 配置 MSTP 多实例

在系统视图下，启用MSTP，

```
[S1]stp enable
[S1]stp mode mstp

[S2]stp enable
[S2]stp mode mstp

[S3]stp enable
[S3]stp mode mstp

[S4]stp enable
[S4]stp mode mstp
```

配置所有交换机都属于同一个区域RG1，修订级别为1。建实例1和VLAN 3,4,5建立映射关系，创建实例2和VLAN 6,7,8建立映射关系，并激活域配置。

```
[S1]stp region-configuration
[S1-mst-region]region-name RG1
[S1-mst-region]revision-level 1
[S1-mst-region]instance 1 vlan 3 4 5
[S1-mst-region]instance 2 vlan 6 7 8
[S1-mst-region]active region-configuration

[S2]stp  region-configuration
[S2-mst-region]region-name RG1
[S2-mst-region]revision-level 1
[S2-mst-region]instance 1 vlan 3 4 5
[S2-mst-region]instance 2 vlan 6 7 8
[S2-mst-region]active region-configuration

[S3]stp  region-configuration
[S3-mst-region]region-name RG1
[S3-mst-region]revision-level 1
[S3-mst-region]instance 1 vlan 3 4 5
[S3-mst-region]instance 2 vlan 6 7 8
[S3-mst-region]active region-configuration

[S4]stp  region-configuration
[S4-mst-region]region-name RG1
[S4-mst-region]revision-level 1
```





```
[S4-mst-region]instance 1 vlan 3 4 5
[S4-mst-region]instance 2 vlan 6 7 8
[S4-mst-region]active region-configuration
```

完成后查看MSTP信息，

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/13        DESI  FORWARDING      NONE

[S2]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/24        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
   1    GigabitEthernet0/0/24        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
   2    GigabitEthernet0/0/24        DESI  FORWARDING      NONE

[S3]dis stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1              DESI  FORWARDING      NONE
   0    Ethernet0/0/13             ROOT  FORWARDING      NONE
   1    Ethernet0/0/1              DESI  FORWARDING      NONE
   1    Ethernet0/0/13             ROOT  FORWARDING      NONE
   2    Ethernet0/0/1              DESI  FORWARDING      NONE
   2    Ethernet0/0/13             ROOT  FORWARDING      NONE

[S4]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1              ROOT  FORWARDING      NONE
   0    Ethernet0/0/24             ALTE  DISCARDING      NONE
   1    Ethernet0/0/1              ROOT  FORWARDING      NONE
   1    Ethernet0/0/24             ALTE  DISCARDING      NONE
   2    Ethernet0/0/1              ROOT  FORWARDING      NONE
   2    Ethernet0/0/24             ALTE  DISCARDING      NONE
```

此时S1为根交换机，S4上的E0/0/24端口为所有MSTP进程的备用端口。

在实例2中，设置S2的优先级为0，S1的优先级为4096，S4的优先级为8192，使S2成为实例2中的根交换机。

```
[S2]stp instance 2 priority 0

[S1]stp instance 2 priority 4096

[S4]stp instance 2 priority 8192
```

配置完成后，查看MSTP的基本信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10       DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/13       DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/10       DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/13       DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/10       ROOT  FORWARDING      NONE
   2    GigabitEthernet0/0/13       DESI  FORWARDING      NONE

[S2]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10       ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/24       DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/10       ROOT  FORWARDING      NONE
   1    GigabitEthernet0/0/24       DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/10       DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/24       DESI  FORWARDING      NONE

[S3]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1              DESI  FORWARDING     NONE
   0    Ethernet0/0/13             ROOT  FORWARDING     NONE
   1    Ethernet0/0/1              DESI  FORWARDING     NONE
   1    Ethernet0/0/13             ROOT  FORWARDING     NONE
   2    Ethernet0/0/1              ALTE  DISCARDING     NONE
   2    Ethernet0/0/13             ROOT  FORWARDING     NONE

[S4]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1              ALTE  DISCARDING     NONE
   0    Ethernet0/0/24             ROOT  FORWARDING     NONE
   1    Ethernet0/0/1              ALTE  DISCARDING     NONE
   1    Ethernet0/0/24             ROOT  FORWARDING     NONE
```

```
  2    Ethernet0/0/1             DESI  FORWARDING     NONE
  2    Ethernet0/0/24            ROOT  FORWARDING     NONE
```

此时S2成为了实例2中的根交换机，S3的E0/0/1成为实例2中的预备端口。但各交换机在实例1中的状态没有改变，验证了每个MST实例都独立计算生成树，互不影响。

## 步骤三. 配置 MSTP 多区域

删除步骤二中所有交换机上的MSTP区域以及优先级的配置。

```
[S1]undo stp region-configuration
[S1]undo stp instance 2 priority

[S2]undo stp region-configuration
[S2]undo stp instance 2 priority

[S3]undo stp region-configuration

[S4]undo stp region-configuration
[S4]undo stp instance 2 priority
```

配置S1和S3到一个MSTP域内，域名为RG1，修订版本号为1。

创建实例1，与VLAN 3,4,5，建立映射关系。

创建实例2，与VLAN 6,7,8,建立映射关系。

```
[S1]stp region-configuration
[S1-mst-region]region-name RG1
[S1-mst-region]revision-level 1
[S1-mst-region]instance 1 vlan 3 4 5
[S1-mst-region]instance 2 vlan 6 7 8
[S1-mst-region]active region-configuration

[S3]stp region-configuration
[S3-mst-region]region-name RG1
[S3-mst-region]revision-level 1
[S3-mst-region]instance 1 vlan 3 4 5
[S3-mst-region]instance 2 vlan 6 7 8
[S3-mst-region]active region-configuration
```

将S2和S4配置到另一个MSTP域内，域名为RG2，修订版本号为2。

创建实例1，和VLAN 3,4,5建立映射关系。

创建实例2，与VLAN 6,7,8建立映射关系，并全部激活域配置，

```
[S2]stp region-configuration
[S2-mst-region]region-name RG2
[S2-mst-region]revision-level 2
[S2-mst-region]instance 1 vlan 3 4 5
[S2-mst-region]instance 2 vlan 6 7 8
[S2-mst-region]active region-configuration

[S4]stp region-configuration
[S4-mst-region]region-name RG2
[S4-mst-region]revision-level 2
[S4-mst-region]instance 1 vlan 3 4 5
[S4-mst-region]instance 2 vlan 6 7 8
[S4-mst-region]active region-configuration
```

配置完成后，查看MSTP基本信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/13        DESI  FORWARDING      NONE

[S2]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
   0    GigabitEthernet0/0/24        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/10        MAST  FORWARDING      NONE
   1    GigabitEthernet0/0/24        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/10        MAST  FORWARDING      NONE

[S3]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1              DESI  FORWARDING      NONE
   0    Ethernet0/0/13             ROOT  FORWARDING      NONE
   1    Ethernet0/0/1              DESI  FORWARDING      NONE
   1    Ethernet0/0/13             ROOT  FORWARDING      NONE
   2    Ethernet0/0/1              DESI  FORWARDING      NONE
   2    Ethernet0/0/13             ROOT  FORWARDING      NONE
```

```
[S4]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1                ALTE  DISCARDING     NONE
   0    Ethernet0/0/24               ROOT  FORWARDING     NONE
   1    Ethernet0/0/1                ALTE  DISCARDING     NONE
   1    Ethernet0/0/24               ROOT  FORWARDING     NONE
   2    Ethernet0/0/1                ALTE  DISCARDING     NONE
   2    Ethernet0/0/24               ROOT  FORWARDING     NONE
```

此时S1为根交换机，S4上的E0/0/1为预备端口。

配置S3在实例0中优先级为0，使其成为CIST的总根，配置S3在实例1中的优先级为0，使其成为实例1的域根，配置S4在实例1中的优先级为0，使其成为实例1的域根。

```
[S3]stp instance 0 priority 0
[S3]stp instance 1 priority 0

[S4]stp instance 1 priority 0
```

配置完成后，查看MSTP基本信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10         DESI  FORWARDING     NONE
   0    GigabitEthernet0/0/13         ROOT  FORWARDING     NONE
   1    GigabitEthernet0/0/10         DESI  FORWARDING     NONE
   1    GigabitEthernet0/0/13         ROOT  FORWARDING     NONE
   2    GigabitEthernet0/0/10         DESI  FORWARDING     NONE
   2    GigabitEthernet0/0/13         DESI  FORWARDING     NONE

[S2]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10         ROOT  FORWARDING     NONE
   0    GigabitEthernet0/0/24         DESI  FORWARDING     NONE
   1    GigabitEthernet0/0/10         MAST  FORWARDING     NONE
   1    GigabitEthernet0/0/24         ROOT  FORWARDING     NONE
   2    GigabitEthernet0/0/10         MAST  FORWARDING     NONE
   2    GigabitEthernet0/0/24         DESI  FORWARDING     NONE

[S3]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1                DESI  FORWARDING     NONE
   0    Ethernet0/0/13               DESI  FORWARDING     NONE
```

```
  1    Ethernet0/0/1             DESI  FORWARDING     NONE
  1    Ethernet0/0/13            DESI  FORWARDING     NONE
  2    Ethernet0/0/1             DESI  FORWARDING     NONE
  2    Ethernet0/0/13            ROOT  FORWARDING     NONE

[S4]display stp brief
 MSTID  Port                     Role  STP State     Protection
  0    Ethernet0/0/1             ALTE  DISCARDING     NONE
  0    Ethernet0/0/24            ROOT  FORWARDING     NONE
  1    Ethernet0/0/1             ALTE  DISCARDING     NONE
  1    Ethernet0/0/24            DESI  FORWARDING     NONE
  2    Ethernet0/0/1             ALTE  DISCARDING     NONE
  2    Ethernet0/0/24            ROOT  FORWARDING     NONE
```

删除S2和S4上的MSTP配置，将S2和S4配置到另一个MSTP域内，域名为RG2，修订版本号为2。创建实例1，和VLAN 6,7,8建立映射关系，创建实例2，与VLAN 3,4,5建立映射关系，并全部激活域配置；

```
[S2]undo stp region-configuration

[S3]undo stp instance 0 priority
[S3]undo stp instance 1 priority

[S4]undo stp region-configuration
[S4]undo stp instance 1 priority

[S2]stp region-configuration
[S2-mst-region]region-name RG2
[S2-mst-region]revision-level 2
[S2-mst-region]instance 1 vlan 6 7 8
[S2-mst-region]instance 2 vlan 3 4 5
[S2-mst-region]active region-configuration

[S4]stp region-configuration
[S4-mst-region]region-name RG2
[S4-mst-region]revision-level 2
[S4-mst-region]instance 1 vlan 6 7 8
[S4-mst-region]instance 2 vlan 3 4 5
[S4-mst-region]active region-configuration
```

配置完成后，查看MSTP基本信息。

```
[S1]display stp brief
 MSTID  Port                     Role  STP State     Protection
```

```
  0    GigabitEthernet0/0/10      DESI  FORWARDING     NONE
  0    GigabitEthernet0/0/13      DESI  FORWARDING     NONE
  1    GigabitEthernet0/0/10      DESI  FORWARDING     NONE
  1    GigabitEthernet0/0/13      DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/10      DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/13      DESI  FORWARDING     NONE

[S2]display stp brief
 MSTID  Port                     Role  STP State     Protection
  0    GigabitEthernet0/0/10      ROOT  FORWARDING     NONE
  0    GigabitEthernet0/0/24      DESI  FORWARDING     NONE
  1    GigabitEthernet0/0/10      MAST  FORWARDING     NONE
  1    GigabitEthernet0/0/24      DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/10      MAST  FORWARDING     NONE
  2    GigabitEthernet0/0/24      DESI  FORWARDING     NONE

[S3]display stp brief
 MSTID  Port                     Role  STP State     Protection
  0    Ethernet0/0/1             DESI  FORWARDING     NONE
  0    Ethernet0/0/13            ROOT  FORWARDING     NONE
  1    Ethernet0/0/1             DESI  FORWARDING     NONE
  1    Ethernet0/0/13            ROOT  FORWARDING     NONE
  2    Ethernet0/0/1             DESI  FORWARDING     NONE
  2    Ethernet0/0/13            ROOT  FORWARDING     NONE

[S4]display stp brief
 MSTID  Port                     Role  STP State     Protection
  0    Ethernet0/0/1             ALTE  DISCARDING     NONE
  0    Ethernet0/0/24            ROOT  FORWARDING     NONE
  1    Ethernet0/0/1             ALTE  DISCARDING     NONE
  1    Ethernet0/0/24            ROOT  FORWARDING     NONE
  2    Ethernet0/0/1             ALTE  DISCARDING     NONE
```

除了Instance 0之外，每个区域的MST实例都独立计算生成树，不管是否包含相同的VLAN，不管VLAN是否和实例映射一致，区域内的生成树计算相互之间互不影响。

## 步骤四. 配置 MSTP 与 STP 兼容

将S1，S2，S3配置在一个MSTP域中，S4单独配置STP。

删除S2上的MSTP配置，在S2上重新创建MSTP。域名为RG1，创建实例1与VLAN 3,4,5，建立映射关系。创建实例2与VLAN6,7,8建立映射关系，并激活

域配置。

```
[S2]undo stp region-configuration
[S2]stp region-configuration
[S2-mst-region]region-name RG1
[S2-mst-region]revision-level 1
[S2-mst-region]instance 1 vlan 3 4 5
[S2-mst-region]instance 2 vlan  6 7 8
[S2-mst-region]active region-configuration
```

开启S2的S0/0/23和S3的E0/0/23端口。

设置S2 ,S3之间的直连链路类为trunk链路 ,接收BPDU ,并且允许所有VLAN通过。

```
[S2]int GigabitEthernet 0/0/23
[S2-GigabitEthernet0/0/23]undo shutdown
[S2-GigabitEthernet0/0/23]port link-type trunk
[S2-GigabitEthernet0/0/23]port trunk all vlan all
[S2-GigabitEthernet0/0/23]bpdu enable

[S3]int Ethernet0/0/23
[S3-Ethernet0/0/23]undo shutdown
[S3-Ethernet0/0/23]port link-type trunk
[S3-Ethernet0/0/23]port trunk allow-pass vlan all
[S3-Ethernet0/0/23]bpdu enable
```

删除S4上的MSTP配置，并在S4上使能STP，

```
[S4]undo stp region-configuration
[S4]stp mode stp
```

配置完成，查看STP基本信息。

```
[S1]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/13        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/13        DESI  FORWARDING      NONE

[S2]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
```

```
  0    GigabitEthernet0/0/23      DESI  FORWARDING     NONE
  0    GigabitEthernet0/0/24      DESI  FORWARDING     NONE
  1    GigabitEthernet0/0/10      ROOT  FORWARDING     NONE
  1    GigabitEthernet0/0/23      DESI  FORWARDING     NONE
  1    GigabitEthernet0/0/24      DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/10      ROOT  FORWARDING     NONE
  2    GigabitEthernet0/0/23      DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/24      DESI  FORWARDING     NONE

[S3]display stp brief
 MSTID  Port                     Role  STP State     Protection
  0    Ethernet0/0/1              DESI  FORWARDING     NONE
  0    Ethernet0/0/13             ROOT  FORWARDING     NONE
  0    Ethernet0/0/23             ALTE  DISCARDING     NONE
  1    Ethernet0/0/1              DESI  FORWARDING     NONE
  1    Ethernet0/0/13             ROOT  FORWARDING     NONE
  1    Ethernet0/0/23             ALTE  DISCARDING     NONE
  2    Ethernet0/0/1              DESI  FORWARDING     NONE
  2    Ethernet0/0/13             ROOT  FORWARDING     NONE
  2    Ethernet0/0/23             ALTE  DISCARDING     NONE

[S4]display stp brief
 MSTID  Port                     Role  STP State     Protection
  0    Ethernet0/0/1              ROOT  FORWARDING     NONE
  0    Ethernet0/0/24             ALTE  DISCARDING     NONE
```

运行STP的S4和运行MSTP的S1、S2、S3中的实例0共同计算CIST。此时S1为CIST的总根。

配置S4优先级为4096，使其成为CIST的总根，

```
[S4]stp priority 4096
```

查看STP基本信息。

```
[S1]display stp brief
 MSTID  Port                     Role  STP State     Protection
  0    GigabitEthernet0/0/10      ROOT  FORWARDING     NONE
  0    GigabitEthernet0/0/13      DESI  FORWARDING     NONE
  1    GigabitEthernet0/0/10      DESI  FORWARDING     NONE
  1    GigabitEthernet0/0/13      DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/10      DESI  FORWARDING     NONE
  2    GigabitEthernet0/0/13      DESI  FORWARDING     NONE

[S2]display stp brief
```

```
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10       DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/23       DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/24       ROOT  FORWARDING      NONE
   1    GigabitEthernet0/0/10       ROOT  FORWARDING      NONE
   1    GigabitEthernet0/0/23       DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/24       MAST  FORWARDING      NONE
   2    GigabitEthernet0/0/10       ROOT  FORWARDING      NONE
   2    GigabitEthernet0/0/23       DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/24       MAST  FORWARDING      NONE

[S3]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1               ALTE  DISCARDING      NONE
   0    Ethernet0/0/13              ALTE  DISCARDING      NONE
   0    Ethernet0/0/23              ROOT  FORWARDING      NONE
   1    Ethernet0/0/1               ALTE  DISCARDING      NONE
   1    Ethernet0/0/13              ROOT  FORWARDING      NONE
   1    Ethernet0/0/23              ALTE  DISCARDING      NONE
   2    Ethernet0/0/1               ALTE  DISCARDING      NONE
   2    Ethernet0/0/13              ROOT  FORWARDING      NONE
   2    Ethernet0/0/23              ALTE  DISCARDING      NONE

[S4]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1               DESI  FORWARDING      NONE
   0    Ethernet0/0/24              DESI  FORWARDING      NONE
```

此时S4成为了CIST的总根，S4上的端口都是指定端口。

## 步骤五.　配置指定端口保护，

在S4的接口E0/0/1和E0/0/24上配置指定端口保护，

```
[S4]int Ethernet0/0/1
[S4-Ethernet0/0/1]stp root-protection
[S4-Ethernet0/0/1]int Ethernet0/0/24
[S4-Ethernet0/0/24]stp root-protection
```

查看此时S4的STP基本信息，

```
[S4]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1               DESI  FORWARDING      ROOT
```

```
  0    Ethernet0/0/24             DESI  DISCARDING     ROOT
```

配置S2在实例0中的优先级为0，模拟抢占CIST根交换机。

```
[S2]stp instance 0 priority 0
```

查看S2，S4上的STP信息。

```
[S2]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/23        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/24        DESI  LEARNING        NONE
   1    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
   1    GigabitEthernet0/0/23        DESI  LEARNING        NONE
   1    GigabitEthernet0/0/24        DESI  LEARNING        NONE
   2    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
   2    GigabitEthernet0/0/23        DESI  LEARNING        NONE
   2    GigabitEthernet0/0/24        DESI  LEARNING        NONE

[S4]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1               DESI  DISCARDING     ROOT
   0    Ethernet0/0/24              DESI  DISCARDING     ROOT
```

此时S4上的端口状态进入Discarding状态，不转发报文。说明此时S4上的端口角色并没有变化，仍然是根交换机。

删除S2上的实例0优先级配置。

```
[S2]undo stp instance 0 priority
```

查看S2，S4上的STP信息。

```
[S2]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/10        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/23        DESI  FORWARDING      NONE
   0    GigabitEthernet0/0/24        ROOT  FORWARDING      NONE
   1    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
   1    GigabitEthernet0/0/23        DESI  FORWARDING      NONE
   1    GigabitEthernet0/0/24        MAST  FORWARDING      NONE
   2    GigabitEthernet0/0/10        ROOT  FORWARDING      NONE
   2    GigabitEthernet0/0/23        DESI  FORWARDING      NONE
   2    GigabitEthernet0/0/24        MAST  FORWARDING      NONE
```

```
[S4]display stp brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/1               DESI  FORWARDING      ROOT
   0    Ethernet0/0/24              DESI  FORWARDING      ROOT
```

当在足够长的时间内（Max Age，默认20秒）没有收到更优的配置消息时，端口会恢复原来的正常状态，进入转发状态。

## 步骤六. 配置边缘端口保护

开启S2的G0/0/9接口，

```
[S2]int GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]undo shutdown
```

将S1的接口G0/0/9配置成边缘端口，并在全局模式下开启边缘端口的保护功能。

```
[S1]int GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]undo shutdown
[S1-GigabitEthernet0/0/9]stp edged-port enable
[S1-GigabitEthernet0/0/9]quit
[S1]stp bpdu-protection
```

查看S1上的STP信息。

```
[S1]display stp interface GigabitEthernet 0/0/9 brief
 MSTID  Port                        Role  STP State     Protection
   0    GigabitEthernet0/0/9          DESI  FORWARDING      BPDU
```

开启S1的G0/0/9接口，使边缘端口端口能收到BPDU，模拟交换机受到攻击。

```
[S1]int GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]undo shutdown
```

观察S1上的现象。

```
Dec 21 2011 08:39:51-05:13 S1 %%01IFNET/4/IF_STATE(l)[3]:Interface
GigabitEthernet0/0/9 has turned into UP state.
Dec 21 2011 08:39:51-05:13 S1 %%01MSTP/4/BPDU_PROTECTION(l)[4]:This edged-port
GigabitEthernet0/0/9 that enabled BPDU-Protection will be shutdown, because it
received BPDU packet!
Dec 21 2011 08:39:52-05:13 S1 %%01IFNET/4/IF_STATE(l)[5]:Interface
GigabitEthernet0/0/9 has turned into DOWN state.
```

配置边缘端口保护之后，一旦启用了边缘端口，使其收到BPDU，会自动关闭该端口。

## 步骤七. 配置环路保护

在S3的接口E0/0/23上配置环路保护。

```
[S3]interface Ethernet0/0/23
[S3-Ethernet0/0/23]stp loop-protection
```

查看S3上该接口的STP信息。

```
[S3]display stp interface Ethernet 0/0/23 brief
 MSTID  Port                        Role  STP State     Protection
   0    Ethernet0/0/23               ROOT  FORWARDING     LOOP
   1    Ethernet0/0/23               ALTE  DISCARDING     LOOP
   2    Ethernet0/0/23               ALTE  DISCARDING     LOOP
```

## 步骤八. 配置 TC-BPDU 保护

在S1上开启对TC类型BPDU报文的保护功能。

```
[S1]stp tc-protection
```

## 附加实验：思考并验证

思考不同交换机上的MSTP域名一致，修订版本号不同会不会产生影响。

思考在步骤四中，如果改变S3中实例1上的优先级为0，则此时四台交换机端口的状态会产生哪些变化。

## 最终设备配置

```
<S1>display current-configuration
#
!Software Version V100R006C00SPC800
```

```
 sysname S1
#
 vlan batch 3 to 8
#
 stp bpdu-protection
 stp tc-protection
#
 stp region-configuration
  region-name RG1
  revision-level 1
  instance 1 vlan 3 to 5
  instance 2 vlan 6 to 8
  active region-configuration
#
interface GigabitEthernet0/0/9
 shutdown
 stp edged-port enable
#
interface GigabitEthernet0/0/10
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/13
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
return

<S2>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 vlan batch 3 to 8
#
 stp region-configuration
  region-name RG1
  revision-level 1
  instance 1 vlan 3 to 5
  instance 2 vlan 6 to 8
  active region-configuration
#
interface GigabitEthernet0/0/9
```

```
#
interface GigabitEthernet0/0/10
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/23
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
interface GigabitEthernet0/0/24
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
return

<S3>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S3
#
 vlan batch 3 to 8
#
 stp region-configuration
  region-name RG1
  revision-level 1
  instance 1 vlan 3 to 5
  instance 2 vlan 6 to 8
  active region-configuration
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
interface Ethernet0/0/13
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
#
interface Ethernet0/0/23
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 stp loop-protection
#
return
```

```
<S4>display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S4
#
 vlan batch 3 to 8 30
#
 stp mode stp
 stp instance 0 priority 4096
#
interface Vlanif30
 ip address 100.100.100.8 255.255.255.0
#
interface Ethernet0/0/1
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 stp root-protection
 undo ntdp enable
 undo ndp enable
#
interface Ethernet0/0/14
 shutdown
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface Ethernet0/0/23
 port link-type access
 port default vlan 30
 undo ntdp enable
 undo ndp enable
 bpdu disable
#
interface Ethernet0/0/24
 port link-type trunk
 port trunk allow-pass vlan 2 to 4094
 stp root-protection
 undo ntdp enable
 undo ndp enable
#
return
```

# 实验 2-3 SEP & Smart Link

## 学习目的

- 掌握SEP的配置方法
- 掌握Smart Link的配置方法
- 了解SEP和Smart Link的混合组网方法

## 拓扑图

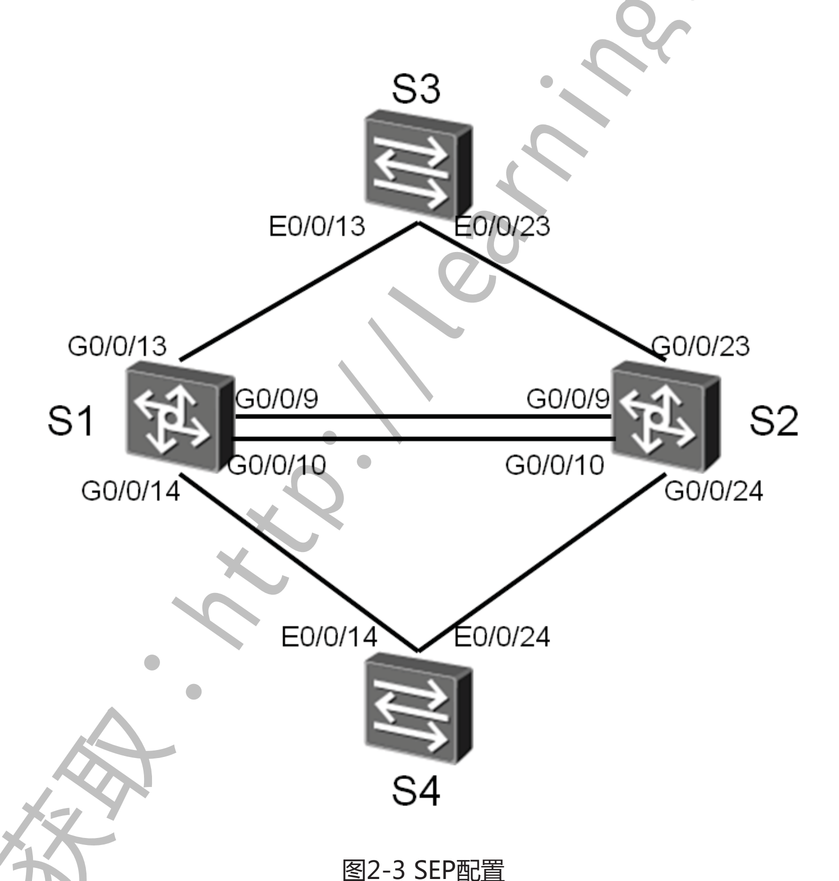



图2-3 SEP配置

## 场景

你是公司的网络管理员。现在公司网络是由四台交换机组成的以太网环境。

交换机S1、S2和S3组成了公司的核心网络。为了提高网络的健壮性，采用了备份型设计，使用SEP协议提供环路保护。在接入层的交换机S4上采用双上行链路的连接方案。使用Smart Link技术实现主备链路，保证网络的可靠性。

## 学习任务

### 步骤一. 基础配置

给所有设备配置名称，并关闭S4的E0/0/1接口，避免对实验造成影响。

```
<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S1
[S1]

<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S2
[S2]

<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S3
[S3]

<Quidway>system-view
Enter system view, return user view with Ctrl+Z.
[Quidway]sysname S4
[S4]interface Ethernet 0/0/1
[S4-Ethernet0/0/1]shutdown
```

### 步骤二. SEP 配置

为了提升网络的健壮性，交换机S1、S2和S3采用了冗余连接。在S1、S2和S3的连接中出现了二个网络环路。

交换机S1的G0/0/9和G0/0/10接口与S2的G0/0/9和G0/0/10接口形成了一个闭合环路，S1的G0/0/13，S3的G0/0/13、G0/0/23和S2的G0/0/23接口形成了一个开放环路。使用SEP协议为这二个网络环路提供冗余保护。

创建SEP段，并配置控制VLAN和指定保护实例。

```
[S1]sep segment 1
[S1-sep-segment1]control-vlan 10
[S1-sep-segment1]protected-instance all
[S1-sep-segment1]quit
[S1]sep segment 2
[S1-sep-segment2]control-vlan 20
[S1-sep-segment2]protected-instance all

[S2]sep segment 1
[S2-sep-segment1]control-vlan 10
[S2-sep-segment1]protected-instance all
[S2-sep-segment1]quit
[S2]sep segment 2
[S2-sep-segment2]control-vlan 20
[S2-sep-segment2]protected-instance all

[S3]sep segment 2
[S3-sep-segment2]control-vlan 20
[S3-sep-segment2]protected-instance all

[S4]sep segment 2
[S4-sep-segment2]control-vlan 20
[S4-sep-segment2]protected-instance all
```

将接口加入SEP段并配置接口角色。

```
[S1]interface GigabitEthernet 0/0/9
[S1-GigabitEthernet0/0/9]stp disable
[S1-GigabitEthernet0/0/9]sep segment 1 edge primary
[S1-GigabitEthernet0/0/9]inter GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]stp disable
[S1-GigabitEthernet0/0/10]sep segment 1 edge secondary
[S1-GigabitEthernet0/0/10]inter GigabitEthernet 0/0/13
[S1-GigabitEthernet0/0/13]stp disable
[S1-GigabitEthernet0/0/13]sep segment 2 edge primary

[S2]interface GigabitEthernet 0/0/23
[S2-GigabitEthernet0/0/23]stp disable
[S2-GigabitEthernet0/0/23]sep segment 2 edge secondary
[S2-GigabitEthernet0/0/23]inter GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]stp disable
[S2-GigabitEthernet0/0/9]sep segment 1
[S2-GigabitEthernet0/0/9]inter GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]stp disable
```

```
[S2-GigabitEthernet0/0/10]sep segment 1

[S3]interface Ethernet 0/0/13
[S3-Ethernet0/0/13]stp disable
[S3-Ethernet0/0/13]sep segment 2
[S3-Ethernet0/0/13]inter ethernet 0/0/23
[S3-Ethernet0/0/23]stp disable
[S3-Ethernet0/0/23]sep segment 2
```

配置阻塞方式和抢占模式。

```
[S1]sep segment 1
[S1-sep-segment1]block port optimal
[S1-sep-segment1]quit
[S1]sep segment 2
[S1-sep-segment2]block port
[S1-sep-segment2]block port optimal

[S2]interface GigabitEthernet 0/0/10
[S2-GigabitEthernet0/0/10]sep segment 1 priority 128

[S3]inter Ethernet 0/0/23
[S3-Ethernet0/0/23]sep segment 2 priority 128

[S1]sep segment 1
[S1-sep-segment1]preempt delay 30
[S1-sep-segment1]quit
[S1]sep segment 2
[S1-sep-segment2]preempt delay 30
```

配置拓扑变更通告。

```
[S1]sep segment 2
[S1-sep-segment2]tc-notify segment 1

[S2]sep segment 2
[S2-sep-segment2]tc-notify segment 1
```

使用命令**display sep topology**查看SEP运行信息。

```
[S1]display sep topology
SEP segment 1
-----------------------------------------------------------------
System Name         Port Name       Port Role      Port Status
-----------------------------------------------------------------
```

```
S1                 GE0/0/9        primary        forwarding
S2                 GE0/0/9        common         forwarding
S2                 GE0/0/10       common         discarding
S1                 GE0/0/10       secondary      forwarding

SEP segment 2
-----------------------------------------------------------------
System Name          Port Name       Port Role      Port Status
-----------------------------------------------------------------
S1                 GE0/0/13       primary        forwarding
S3                 Eth0/0/13      common         forwarding
S3                 Eth0/0/23      common         forwarding
S2                 GE0/0/23       secondary      discarding
```

关闭S2的G0/0/9接口验证SEP运行情况。

```
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]shutdown
[S2-GigabitEthernet0/0/9]quit
[S2]display sep topology
SEP segment 1
SEP detects a segment failure that may be caused by an incomplete topology
-----------------------------------------------------------------
System Name          Port Name       Port Role      Port Status
-----------------------------------------------------------------
S1                 GE0/0/9        secondary      discarding
S1                 GE0/0/10       secondary      forwarding
S2                 GE0/0/10       common         forwarding
S2                 GE0/0/9        common         discarding

SEP segment 2
-----------------------------------------------------------------
System Name          Port Name       Port Role      Port Status
-----------------------------------------------------------------
S1                 GE0/0/13       primary        forwarding
S3                 Eth0/0/13      common         forwarding
S3                 Eth0/0/23      common         forwarding
S2                 GE0/0/23       secondary      discarding
```

打开S2的G0/0/9接口，关闭S3的E0/0/13接口验证SEP运行情况。

```
[S2]interface GigabitEthernet 0/0/9
[S2-GigabitEthernet0/0/9]undo shutdown
```

```
[S3]inter Ethernet 0/0/13
[S3-Ethernet0/0/13]shutdown
[S3]display sep topology
SEP segment 2
SEP detects a segment failure that may be caused by an incomplete topology
-----------------------------------------------------------------
System Name          Port Name        Port Role      Port Status
-----------------------------------------------------------------
S2                 GE0/0/23         secondary      forwarding
S3                 Eth0/0/23        common         forwarding
S3                 Eth0/0/13        common         discarding
```

打开S3的E0/0/13接口，验证SEP运行情况。

```
[S3]interface Ethernet 0/0/13
[S3-Ethernet0/0/13]undo shutdown

[S1]display sep topology
SEP segment 1
-----------------------------------------------------------------
System Name          Port Name        Port Role      Port Status
-----------------------------------------------------------------
S1                 GE0/0/9          primary        forwarding
S2                 GE0/0/9          common         forwarding
S2                 GE0/0/10         common         discarding
S1                 GE0/0/10         secondary      forwarding

SEP segment 2
-----------------------------------------------------------------
System Name          Port Name        Port Role      Port Status
-----------------------------------------------------------------
S1                 GE0/0/13         primary        forwarding
S3                 Eth0/0/13        common         forwarding
S3                 Eth0/0/23        common         discarding
S2                 GE0/0/23         secondary      forwarding
```

从输出结果可知，SEP能够在故障发生的时候把网络拓扑进行相应改变。在故障恢复之后能够正确阻塞指定的阻塞接口。

## 步骤三. Smart Link 配置

Smart Link技术能为用户提供冗余的上行连接。在交换机S4上使用Smart Link技术将E0/0/14接口配置为主接口，E0/0/24接口配置为从接口。通过Smart

Link实现当主接口出现故障时能够快速切换到从接口，保障用户通信不中断。

在S4上配置控制VLAN，并将接口加入该VLAN。

```
[S4]vlan 100
[S4-vlan100]quit
[S4]interface Ethernet 0/0/14
[S4-Ethernet0/0/14]port link-type trunk
[S4-Ethernet0/0/14]port trunk allow-pass vlan 100
[S4-Ethernet0/0/14]inter ethe0/0/24
[S4-Ethernet0/0/24]port link-type trunk
[S4-Ethernet0/0/24]port trunk allow-pass vlan 100
```

在S1和S2上配置控制VLAN，并将S1的G0/0/14和S2的G0/0/14加入该VLAN。

```
[S1]vlan 100
[S1-vlan100]quit
[S1]interface GigabitEthernet 0/0/14
[S1-GigabitEthernet0/0/14]port link-type trunk
[S1-GigabitEthernet0/0/14]port trunk allow-pass vlan 100

[S2]vlan 100
[S2-vlan100]quit
[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]port link-type trunk
[S2-GigabitEthernet0/0/24]port trunk allow-pass vlan 100
```

关闭S4的E0/0/14和E0/0/24这二个接口的STP功能。

```
[S4]interface Ethernet 0/0/14
[S4-Ethernet0/0/14]stp disable
[S4-Ethernet0/0/14]inter ethe0/0/24
[S4-Ethernet0/0/24]stp disable
```

将S4的E0/0/14加入Smart Link组并指定为主接口，S4的E0/0/24加入Smart Link组并指定为从接口。

```
[S4]smart-link group 1
[S4-smlk-group1]port Ethernet 0/0/14 master
[S4-smlk-group1]port Ethernet 0/0/24 slave
```

在S4上开启回切功能并设置回切时间。

```
[S4]smart-link group 1
[S4-smlk-group1]restore enable
```

```
[S4-smlk-group1]timer wtr 30
```

在S4上开启发送Flush报文功能，在S1和S2上开启接受Flush报文功能。

```
[S4]smart-link group 1
[S4-smlk-group1]flush send control-vlan 100 password simple huawei

[S1]interface GigabitEthernet 0/0/14
[S1-GigabitEthernet0/0/14]smart-link flush receive control-vlan 100 password
simple huawei

[S2]interface GigabitEthernet 0/0/24
[S2-GigabitEthernet0/0/24]smart-link flush receive control-vlan 100 password
simple huawei
```

在S4上开启Smart Link功能。

```
[S4]smart-link group 1
[S4-smlk-group1]smart-link enable
```

使用命令**display smart-link group**查看S4上的Smart Link组信息。

```
[S4]display smart-link group 1
Smart Link group 1 information :
  Smart Link group was enabled
  Wtr-time is: 30 sec.
  There is no Load-Balance
  There is no protected-vlan reference-instance
  DeviceID: 5489-98ec-f012  Control-vlan ID: 100
     Member             Role  State    Flush Count Last-Flush-Time
  ----------------------------------------------------------------------
  Ethernet0/0/14        Master Active   1         2008/01/05 03:11:18
UTC-05:13
  Ethernet0/0/24        Slave  Inactive 0         0000/00/00 00:00:00
UTC+00:00
```

关闭S4的E0/0/14接口验证Smart Link功能。

```
[S4]interface Ethernet 0/0/14
[S4-Ethernet0/0/14]shutdown
[S4]display smart-link group 1
Smart Link group 1 information :
  Smart Link group was enabled
  Wtr-time is: 30 sec.
  There is no Load-Balance
```

```
There is no protected-vlan reference-instance
DeviceID: 5489-98ec-f012  Control-vlan ID: 100
   Member            Role   State    Flush Count Last-Flush-Time
----------------------------------------------------------------------
Ethernet0/0/14        Master Inactive 1         2008/01/05 03:11:18 UTC-05:13
Ethernet0/0/24        Slave  Active   1         2008/01/05 03:14:57 UTC-05:13
```

从命令输出结果可知，Smart Link能够正确的在故障发生的时候进行链路切换。

## 步骤四.  SEP 和 Smart Link 混合组网

当在SEP和Smart Link混合组网中Smart Link处于下层网络时，SEP必须知道下层网络的情况才能适应网络的变化。需要在网络中配置SEP和Smart Link信息通信的功能。

在S1和S2上开启处理Smart Link Flucsh报文能力。

```
[S1]sep segment 1
[S1-sep-segment1]deal smart-link-flush

[S2]sep segment 1
[S2-sep-segment1]deal smart-link-flush
```

## 附加实验：思考并验证

对比SEP与STP，列出它们各自的优缺点。

## 最终设备配置

```
[S1]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S1
#
 vlan batch 10 20 100
#
sep segment 1
 control-vlan 10
 block port optimal
 preempt delay 30
```

```
 protected-instance 0 to 48
 deal smart-link-flush
sep segment 2
 control-vlan 20
 block port optimal
 preempt delay 30
 tc-notify segment 1
 protected-instance 0 to 48
#
interface GigabitEthernet0/0/9
 port hybrid tagged vlan 10
 stp disable
 sep segment 1 edge primary
#
interface GigabitEthernet0/0/10
 port hybrid tagged vlan 10
 stp disable
 sep segment 1 edge secondary
#
interface GigabitEthernet0/0/13
 port hybrid tagged vlan 20
 stp disable
 sep segment 2 edge primary
#
interface GigabitEthernet0/0/14
 port link-type trunk
 port trunk allow-pass vlan 100
 smart-link flush receive control-vlan 100 password simple huawei
#
Return
```

```
[S2]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S2
#
 vlan batch 10 20 100
#
sep segment 1
 control-vlan 10
 protected-instance 0 to 48
 deal smart-link-flush
sep segment 2
```

```
 control-vlan 20
 tc-notify segment 1
 protected-instance 0 to 48
#
interface GigabitEthernet0/0/9
 port hybrid tagged vlan 10
 stp disable
 sep segment 1
#
interface GigabitEthernet0/0/10
 port hybrid tagged vlan 10
 stp disable
 sep segment 1
 sep segment 1 priority 128
#
interface GigabitEthernet0/0/23
 port hybrid tagged vlan 20
 stp disable
 sep segment 2 edge secondary
#
interface GigabitEthernet0/0/24
 port link-type trunk
 port trunk allow-pass vlan 100
 smart-link flush receive control-vlan 100 password simple huawei
#
return
```

```
[S3]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S3
#
 vlan batch 20
#
sep segment 2
 control-vlan 20
 protected-instance 0 to 48
#
#
interface Ethernet0/0/13
 port hybrid tagged vlan 20
 stp disable
 sep segment 2
```

```
#
interface Ethernet0/0/23
 port hybrid tagged vlan 20
 stp disable
 sep segment 2
 sep segment 2 priority 128
#
Return

[S4]display current-configuration
#
!Software Version V100R006C00SPC800
 sysname S4
#
 vlan batch 20 100
#
sep segment 2
 control-vlan 20
 protected-instance 0 to 48
#
interface Ethernet0/0/1
 shutdown
#
interface Ethernet0/0/14
 shutdown
 port link-type trunk
 port trunk allow-pass vlan 100
 stp disable
#
interface Ethernet0/0/24
 port link-type trunk
 port trunk allow-pass vlan 100
 stp disable
#
smart-link group 1
 restore enable
 smart-link enable
 port Ethernet0/0/14 master
 port Ethernet0/0/24 slave
 timer wtr 30
 flush send control-vlan 100 password simple huawei
#
Return
```

# 第三章 MPLS配置

## 实验 3-1 MPLS LDP 配置

### 学习目的

- 掌握启用和关闭MPLS的方法
- 掌握启用和关闭MPLS LDP配置的方法
- 掌握使用MPLS LDP配置LSP会话的方法
- 掌握在各LSR上修改LDP LSP的触发策略的配置

### 拓扑图

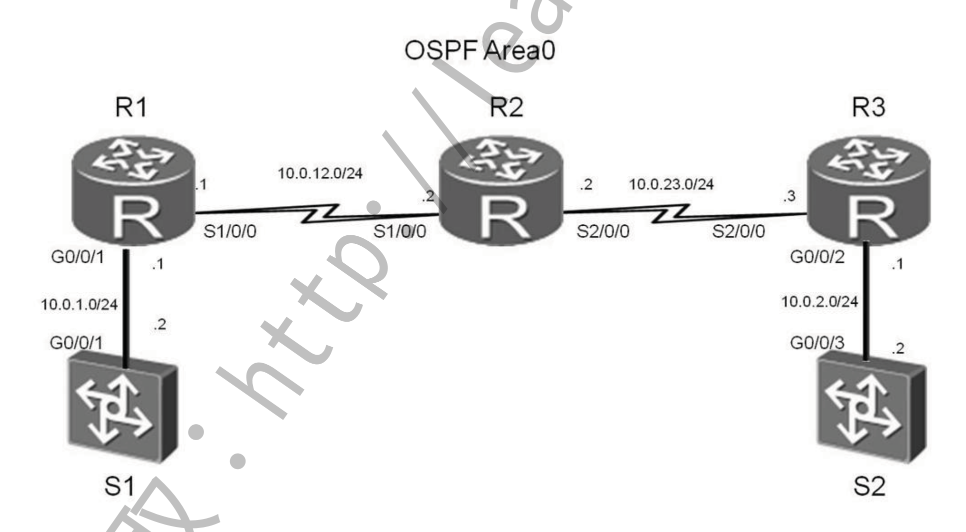



图3-1. MPLS LDP实验拓扑图

### 场景

你是公司的网络管理员。公司的网络采用了IP网络，为解决IP网络转发性能低下问题，决定使用MPLS技术来提高路由器的转发速度。而静态LSP由管理员手工配置，LDP是专为标签发布而制定的标签分发协议,为了配置灵活采用LDP

来建立MPLS LSP。

## 学习任务

### 步骤五. 基本配置与 IP 编址

给所有路由器配置IP地址和掩码。

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname S1
[S1]interface Vlanif 1
[S1-Vlanif1]ip address 10.0.1.2 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.1.1 24
[R1-GigabitEthernet0/0/1]quit
[R1]interface s1/0/0
[R1-Serial1/0/0]ip address 10.0.12.1 24
[R1-Serial1/0/0]quit
[R1]interface loopback 0
[R1-LoopBack0]ip address 2.2.2.2 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface s1/0/0
[R2-Serial1/0/0]ip address 10.0.12.2 24
[R2-Serial1/0/0]quit
[R2]interface s2/0/0
[R2-Serial2/0/0]ip address 10.0.23.2 24
[R2-Serial2/0/0]quit
[R2]interface loopback 0
[R2-LoopBack0]ip address 3.3.3.3 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
[R3]interface GigabitEthernet 0/0/2
```





```
[R3-GigabitEthernet0/0/2]ip address 10.0.2.1 24
[R3-GigabitEthernet0/0/2]quit
[R3]interface s2/0/0
[R3-Serial2/0/0]ip address 10.0.23.3 24
[R3-Serial2/0/0]quit
[R3]interface loopback 0
[R3-LoopBack0]ip address 4.4.4.4 24

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname S2
[S2]interface Vlanif 1
[S2-Vlanif1]ip address 10.0.2.2 24
```

配置完成后，请自行测试直连链路的连通性。

## 步骤六. 配置单区域 OSPF

配置10.0.12.0/24、10.0.23.0/24、10.0.1.0/24、10.0.2.0/24四个网段属于OSPF区域0。

```
[S1]ospf 1 router-id 1.1.1.1
[S1-ospf-1]area 0
[S1-ospf-1-area-0.0.0.0]network 10.0.1.0 0.0.0.255

[R1]ospf 1 router-id 2.2.2.2
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.0.1.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]network 10.0.12.0 0.0.0.255
[R1-ospf-1-area-0.0.0.0]net 2.2.2.0 0.0.0.255

[R2]ospf 1 router-id 3.3.3.3
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]network 10.0.12.0 0.0.0.255
[R2-ospf-1-area-0.0.0.0]network 10.0.23.0 0.0.0.255
[R2-ospf-1-area-0.0.0.0]net 3.3.3.0 0.0.0.255


[R3]ospf 1 router-id 4.4.4.4
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]net
[R3-ospf-1-area-0.0.0.0]network 10.0.23.0 0.0.0.255
[R3-ospf-1-area-0.0.0.0]network 10.0.2.0 0.0.0.255
[R3-ospf-1-area-0.0.0.0]net 4.4.4.0 0.0.0.255
```

```
[S2]ospf 1 router-id 5.5.5.5
[S2-ospf-1]area 0
[S2-ospf-1-area-0.0.0.0]network 10.0.2.0 0.0.0.255
```

配置完成后，查看设备的路由表，并测试全网的连通性。

```
[R2]ping 10.0.1.2
  PING 10.0.1.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.2: bytes=56 Sequence=1 ttl=253 time=36 ms
    Reply from 10.0.1.2: bytes=56 Sequence=2 ttl=253 time=31 ms
    Reply from 10.0.1.2: bytes=56 Sequence=3 ttl=253 time=31 ms
    Reply from 10.0.1.2: bytes=56 Sequence=4 ttl=253 time=31 ms
    Reply from 10.0.1.2: bytes=56 Sequence=5 ttl=253 time=31 ms

  --- 10.0.1.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 31/32/36 ms

[R2]ping 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=253 time=38 ms
    Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=253 time=33 ms
    Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=253 time=33 ms
    Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=253 time=33 ms
    Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=253 time=33 ms

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 33/34/38 ms
```

使用display ip routing-table命令查看各路由器OSPF路由表。

```
[R2]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
--
Routing Tables: Public
         Destinations : 19      Routes : 19
```

```
Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        2.2.2.2/32  OSPF    10   1562        D   10.0.12.1       Serial1/0/0
        3.3.3.0/24  Direct  0    0           D   3.3.3.3         LoopBack0
        3.3.3.3/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      3.3.3.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
        4.4.4.4/32  OSPF    10   1562        D   10.0.23.3       Serial2/0/0
       10.0.1.0/24  OSPF    10   1563        D   10.0.12.1       Serial1/0/0
       10.0.2.0/24  OSPF    10   1563        D   10.0.23.3       Serial2/0/0
      10.0.12.0/24  Direct  0    0           D   10.0.12.2       Serial1/0/0
      10.0.12.1/32  Direct  0    0           D   10.0.12.1       Serial1/0/0
      10.0.12.2/32  Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.12.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.23.0/24  Direct  0    0           D   10.0.23.2       Serial2/0/0
      10.0.23.2/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.23.3/32  Direct  0    0           D   10.0.23.3       Serial2/0/0
    10.0.23.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

## 步骤七. MPLS LDP 配置

在各LSR上配置全局MPLS和LDP。

```
[R1]mpls lsr-id 2.2.2.2
[R1]mpls
Info: Mpls starting, please wait... OK!
[R1-mpls]mpls ldp

[R2]mpls lsr-id 3.3.3.3
[R2]mpls
Info: Mpls starting, please wait... OK!
[R2-mpls]mpls ldp

[R3]mpls lsr-id 4.4.4.4
[R3]mpls
Info: Mpls starting, please wait... OK!
[R3-mpls]mpls ldp
```

在各LSR接口上配置MPLS和LDP。

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]mpls
[R1-Serial1/0/0]mpls ldp

[R2]inter Serial 1/0/0
[R2-Serial1/0/0]mpls
[R2-Serial1/0/0]mpls ldp
[R2-Serial1/0/0]interface Serial 2/0/0
[R2-Serial2/0/0]mpls
[R2-Serial2/0/0]mpls ldp

[R3]interface Serial 2/0/0
[R3-Serial2/0/0]mpls
[R3-Serial2/0/0]mpls ldp
```

配置完成后，在节点上执行display mpls ldp session命令，可以看到R1和R2和R3之间的本地LDP会话状态为“Operational”。

```
[R1]display mpls ldp session
 LDP Session(s) in Public Network
 Codes: LAM(Label Advertisement Mode), SsnAge Unit(DDDD:HH:MM)
 A '*' before a session means the session is being deleted.
 ------------------------------------------------------------------------------
 PeerID           Status      LAM  SsnRole  SsnAge      KASent/Rcv
 ------------------------------------------------------------------------------
 3.3.3.3:0         Operational DU   Passive  0000:00:10  41/41
 ------------------------------------------------------------------------------
TOTAL: 1 session(s) Found.

[R2]display mpls ldp session
 LDP Session(s) in Public Network
 Codes: LAM(Label Advertisement Mode), SsnAge Unit(DDDD:HH:MM)
 A '*' before a session means the session is being deleted.
 ------------------------------------------------------------------------------
 PeerID           Status      LAM  SsnRole  SsnAge      KASent/Rcv
 ------------------------------------------------------------------------------
 2.2.2.2:0         Operational DU   Active   0000:00:11  46/46
 4.4.4.4:0         Operational DU   Passive  0000:00:10  43/43
 ------------------------------------------------------------------------------
 TOTAL: 2 session(s) Found.

[R3]display mpls ldp session
 LDP Session(s) in Public Network
 Codes: LAM(Label Advertisement Mode), SsnAge Unit(DDDD:HH:MM)
```

```
A '*' before a session means the session is being deleted.
------------------------------------------------------------------------------
PeerID           Status      LAM  SsnRole  SsnAge      KASent/Rcv
------------------------------------------------------------------------------
3.3.3.3:0        Operational DU   Active   0000:00:11  46/46
------------------------------------------------------------------------------
TOTAL: 1 session(s) Found.
```

## 步骤八. LDP 建立 LSP

在配置完成后，各LSR已根据默认的LDP LSP触发策略，即所有主机路由触发建立LDP LSP。

在各LSR上执行display mpls ldp lsp命令，可以看到所有主机路由都触发建立了LDP LSP。

```
[R1]display mpls ldp lsp
 LDP LSP Information
 ------------------------------------------------------------------------------
 DestAddress/Mask   In/OutLabel    UpstreamPeer    NextHop         OutInterface
 ------------------------------------------------------------------------------
 2.2.2.2/32         3/NULL         3.3.3.3         127.0.0.1       InLoop0
*2.2.2.2/32         Liberal/1024                   DS/3.3.3.3
 3.3.3.3/32         NULL/3         -               10.0.12.2       S1/0/0
 3.3.3.3/32         1024/3         3.3.3.3         10.0.12.2       S1/0/0
 4.4.4.4/32         NULL/1025      -               10.0.12.2       S1/0/0
 4.4.4.4/32         1025/1025      3.3.3.3         10.0.12.2       S1/0/0
 ------------------------------------------------------------------------------
 TOTAL: 5 Normal LSP(s) Found.
 TOTAL: 1 Liberal LSP(s) Found.
 TOTAL: 0 Frr LSP(s) Found.
 A '*' before an LSP means the LSP is not established
 A '*' before a Label means the USCB or DSCB is stale
 A '*' before a UpstreamPeer means the session is in GR state
 A '*' before a DS means the session is in GR state
 A '*' before a NextHop means the LSP is FRR LSP

[R2]display mpls ldp lsp
 LDP LSP Information
 ------------------------------------------------------------------------------
 DestAddress/Mask   In/OutLabel    UpstreamPeer    NextHop         OutInterface
 ------------------------------------------------------------------------------
 2.2.2.2/32         NULL/3         -               10.0.12.1       S1/0/0
```

```
 2.2.2.2/32        1024/3        2.2.2.2        10.0.12.1      S1/0/0
 2.2.2.2/32        1024/3        4.4.4.4        10.0.12.1      S1/0/0
*2.2.2.2/32        Liberal/1024                 DS/4.4.4.4
 3.3.3.3/32        3/NULL        2.2.2.2        127.0.0.1      InLoop0
 3.3.3.3/32        3/NULL        4.4.4.4        127.0.0.1      InLoop0
*3.3.3.3/32        Liberal/1024                 DS/2.2.2.2
*3.3.3.3/32        Liberal/1025                 DS/4.4.4.4
 4.4.4.4/32        NULL/3        -             10.0.23.3      S2/0/0
 4.4.4.4/32        1025/3        2.2.2.2        10.0.23.3      S2/0/0
 4.4.4.4/32        1025/3        4.4.4.4        10.0.23.3      S2/0/0
*4.4.4.4/32        Liberal/1025                 DS/2.2.2.2
 ----------------------------------------------------------------------------
 TOTAL: 8 Normal LSP(s) Found.
 TOTAL: 4 Liberal LSP(s) Found.
 TOTAL: 0 Frr LSP(s) Found.
 A '*' before an LSP means the LSP is not established
 A '*' before a Label means the USCB or DSCB is stale
 A '*' before a UpstreamPeer means the session is in GR state
 A '*' before a DS means the session is in GR state
 A '*' before a NextHop means the LSP is FRR LSP


[R3]display mpls ldp lsp
 LDP LSP Information
 ----------------------------------------------------------------------------
 DestAddress/Mask  In/OutLabel   UpstreamPeer   NextHop       OutInterface
 ----------------------------------------------------------------------------
 2.2.2.2/32        NULL/1024     -             10.0.23.2      S2/0/0
 2.2.2.2/32        1024/1024     3.3.3.3        10.0.23.2      S2/0/0
 3.3.3.3/32        NULL/3        -             10.0.23.2      S2/0/0
 3.3.3.3/32        1025/3        3.3.3.3        10.0.23.2      S2/0/0
 4.4.4.4/32        3/NULL        3.3.3.3        127.0.0.1      InLoop0
*4.4.4.4/32        Liberal/1025                 DS/3.3.3.3
 ----------------------------------------------------------------------------
 TOTAL: 5 Normal LSP(s) Found.
 TOTAL: 1 Liberal LSP(s) Found.
 TOTAL: 0 Frr LSP(s) Found.
 A '*' before an LSP means the LSP is not established
 A '*' before a Label means the USCB or DSCB is stale
 A '*' before a UpstreamPeer means the session is in GR state
 A '*' before a DS means the session is in GR state
 A '*' before a NextHop means the LSP is FRR LSP
```

通常情况下，使用缺省的触发策略，即由“host”方式触发建立LDP LSP。

在各LSR上将LDP LSP的触发策略修改为all，使路由表中的所有静态路由和IGP表项都可以触发建立LDP LSP。

```
[R1]mpls
[R1-mpls]lsp-trigger all

[R2]mpls
[R2-mpls]lsp-trigger all

[R3]mpls
[R3-mpls]lsp-trigger all
```

配置完成后，在各节点上执行display mpls ldp lsp命令，可以看到LDP LSP的建立情况。

```
[R1]display mpls ldp lsp
 LDP LSP Information
 -------------------------------------------------------------------------------
 DestAddress/Mask   In/OutLabel    UpstreamPeer    NextHop        OutInterface
 -------------------------------------------------------------------------------
 2.2.2.0/24        3/NULL        3.3.3.3        2.2.2.2        Loop0
 2.2.2.2/32        3/NULL        3.3.3.3        127.0.0.1       InLoop0
*2.2.2.2/32        Liberal/1024                 DS/3.3.3.3
*3.3.3.0/24        Liberal/3                    DS/3.3.3.3
 3.3.3.3/32        NULL/3        -              10.0.12.2      S1/0/0
 3.3.3.3/32        1024/3        3.3.3.3        10.0.12.2      S1/0/0
 4.4.4.4/32        NULL/1025     -              10.0.12.2      S1/0/0
 4.4.4.4/32        1025/1025     3.3.3.3        10.0.12.2      S1/0/0
 10.0.1.0/24       3/NULL        3.3.3.3        10.0.1.1       GE0/0/1
*10.0.1.0/24       Liberal/1026                 DS/3.3.3.3
 10.0.2.0/24       NULL/1027     -              10.0.12.2      S1/0/0
 10.0.2.0/24       1027/1027     3.3.3.3        10.0.12.2      S1/0/0
 10.0.12.0/24      3/NULL        3.3.3.3        10.0.12.1      S1/0/0
*10.0.12.0/24      Liberal/3                    DS/3.3.3.3
 10.0.23.0/24      NULL/3        -              10.0.12.2      S1/0/0
 10.0.23.0/24      1026/3        3.3.3.3        10.0.12.2      S1/0/0
 -------------------------------------------------------------------------------
 TOTAL: 12 Normal LSP(s) Found.
 TOTAL: 4 Liberal LSP(s) Found.
 TOTAL: 0 Frr LSP(s) Found.
 A '*' before an LSP means the LSP is not established
 A '*' before a Label means the USCB or DSCB is stale
 A '*' before a UpstreamPeer means the session is in GR state
 A '*' before a DS means the session is in GR state
```



```
 A '*' before a NextHop means the LSP is FRR LSP

[R2]dis mpls ldp lsp
 LDP LSP Information
 ---------------------------------------------------------------------------
 DestAddress/Mask   In/OutLabel    UpstreamPeer    NextHop        OutInterface
 ---------------------------------------------------------------------------
*2.2.2.0/24        Liberal/3                     DS/2.2.2.2
 2.2.2.2/32        NULL/3        -              10.0.12.1      S1/0/0
 2.2.2.2/32        1024/3        2.2.2.2         10.0.12.1      S1/0/0
 2.2.2.2/32        1024/3        4.4.4.4         10.0.12.1      S1/0/0
*2.2.2.2/32        Liberal/1024                  DS/4.4.4.4
 3.3.3.0/24        3/NULL        2.2.2.2         3.3.3.3        Loop0
 3.3.3.0/24        3/NULL        4.4.4.4         3.3.3.3        Loop0
 3.3.3.3/32        3/NULL        2.2.2.2         127.0.0.1      InLoop0
 3.3.3.3/32        3/NULL        4.4.4.4         127.0.0.1      InLoop0
*3.3.3.3/32        Liberal/1024                  DS/2.2.2.2
*3.3.3.3/32        Liberal/1025                  DS/4.4.4.4
*4.4.4.0/24        Liberal/3                     DS/4.4.4.4
 4.4.4.4/32        NULL/3        -              10.0.23.3      S2/0/0
 4.4.4.4/32        1025/3        2.2.2.2         10.0.23.3      S2/0/0
 4.4.4.4/32        1025/3        4.4.4.4         10.0.23.3      S2/0/0
*4.4.4.4/32        Liberal/1025                  DS/2.2.2.2
 10.0.1.0/24       NULL/3        -              10.0.12.1      S1/0/0
 10.0.1.0/24       1026/3        2.2.2.2         10.0.12.1      S1/0/0
 10.0.1.0/24       1026/3        4.4.4.4         10.0.12.1      S1/0/0
*10.0.1.0/24       Liberal/1026                  DS/4.4.4.4
 10.0.2.0/24       NULL/3        -              10.0.23.3      S2/0/0
 10.0.2.0/24       1027/3        2.2.2.2         10.0.23.3      S2/0/0
 10.0.2.0/24       1027/3        4.4.4.4         10.0.23.3      S2/0/0
*10.0.2.0/24       Liberal/1027                  DS/2.2.2.2
 10.0.12.0/24      3/NULL        2.2.2.2         10.0.12.2      S1/0/0
 10.0.12.0/24      3/NULL        4.4.4.4         10.0.12.2      S1/0/0
*10.0.12.0/24      Liberal/3                     DS/2.2.2.2
*10.0.12.0/24      Liberal/1027                  DS/4.4.4.4
 10.0.23.0/24      3/NULL        2.2.2.2         10.0.23.2      S2/0/0
 10.0.23.0/24      3/NULL        4.4.4.4         10.0.23.2      S2/0/0
*10.0.23.0/24      Liberal/1026                  DS/2.2.2.2
*10.0.23.0/24      Liberal/3                     DS/4.4.4.4
 ---------------------------------------------------------------------------
 TOTAL: 20 Normal LSP(s) Found.
 TOTAL: 12 Liberal LSP(s) Found.
 TOTAL: 0 Frr LSP(s) Found.
```

```
 A '*' before an LSP means the LSP is not established
 A '*' before a Label means the USCB or DSCB is stale
 A '*' before a UpstreamPeer means the session is in GR state
 A '*' before a DS means the session is in GR state
 A '*' before a NextHop means the LSP is FRR LSP

[R3]display mpls ldp lsp
  LDP LSP Information
 ----------------------------------------------------------------------------
 DestAddress/Mask   In/OutLabel    UpstreamPeer    NextHop        OutInterface
 ----------------------------------------------------------------------------
 2.2.2.2/32         NULL/1024      -              10.0.23.2      S2/0/0
 2.2.2.2/32         1024/1024      3.3.3.3         10.0.23.2      S2/0/0
*3.3.3.0/24         Liberal/3                     DS/3.3.3.3
 3.3.3.3/32         NULL/3         -              10.0.23.2      S2/0/0
 3.3.3.3/32         1025/3         3.3.3.3         10.0.23.2      S2/0/0
 4.4.4.0/24         3/NULL         3.3.3.3         4.4.4.4       Loop0
 4.4.4.4/32         3/NULL         3.3.3.3         127.0.0.1      InLoop0
*4.4.4.4/32         Liberal/1025                   DS/3.3.3.3
 10.0.1.0/24        NULL/1026      -               10.0.23.2      S2/0/0
 10.0.1.0/24        1026/1026      3.3.3.3          10.0.23.2      S2/0/0
 10.0.2.0/24        3/NULL         3.3.3.3          10.0.2.1      GE0/0/2
*10.0.2.0/24        Liberal/1027                   DS/3.3.3.3
 10.0.12.0/24       NULL/3         -              10.0.23.2      S2/0/0
 10.0.12.0/24       1027/3         3.3.3.3          10.0.23.2      S2/0/0
 10.0.23.0/24       3/NULL         3.3.3.3          10.0.23.3      S2/0/0
*10.0.23.0/24       Liberal/3                     DS/3.3.3.3
 ----------------------------------------------------------------------------
 TOTAL: 12 Normal LSP(s) Found.
 TOTAL: 4 Liberal LSP(s) Found.
 TOTAL: 0 Frr LSP(s) Found.
 A '*' before an LSP means the LSP is not established
 A '*' before a Label means the USCB or DSCB is stale
 A '*' before a UpstreamPeer means the session is in GR state
 A '*' before a DS means the session is in GR state
 A '*' before a NextHop means the LSP is FRR LSP
```

## 步骤九. LDP Inbound 策略配置

R1性能较低，如果不对R1收到的标签进行控制，则会建立大量的LSP，消耗大量内存，R1无法承受。

配置LDP Inbound策略，R1只接收到达R2的标签映射消息，使R1只建立到R2的LSP，从而减少资源的浪费。

在R1上执行display mpls lsp命令，查看已经建立的LSP。

```
[R1]displa mpls lsp
----------------------------------------------------------------------------
              LSP Information: LDP LSP
----------------------------------------------------------------------------
FEC                In/Out Label  In/Out IF                   Vrf Name
3.3.3.3/32          NULL/3       -/S1/0/0
3.3.3.3/32          1024/3       -/S1/0/0
2.2.2.2/32          3/NULL       -/-
4.4.4.4/32          NULL/1025     -/S1/0/0
4.4.4.4/32          1025/1025     -/S1/0/0
10.0.12.0/24        3/NULL        -/-
10.0.1.0/24         3/NULL       -/-
2.2.2.0/24          3/NULL       -/-
10.0.23.0/24        NULL/3        -/S1/0/0
10.0.23.0/24        1026/3        -/S1/0/0
10.0.2.0/24         NULL/1027     -/S1/0/0
10.0.2.0/24         1027/1027     -/S1/0/0
```

可以看到R1上建立了到R2、R3的LSP。在R1上配置Inbound策略，只允许到R2的路由通过。

```
[R1]ip ip-prefix prefix1 permit 10.0.12.0 24
[R1]mpls ldp
[R1-mpls-ldp]inbound peer 3.3.3.3 fec ip-prefix prefix1
[R1-mpls-ldp]quit
[R1]displa mpls lsp
----------------------------------------------------------------------------
              LSP Information: LDP LSP
----------------------------------------------------------------------------
FEC                In/Out Label  In/Out IF                   Vrf Name
2.2.2.2/32          3/NULL       -/-
10.0.12.0/24        3/NULL        -/-
10.0.1.0/24         3/NULL       -/-
2.2.2.0/24          3/NULL       -/-
```

## 附加实验：思考并验证

思考一下，步骤五中如果想在R1上配置只给R1发送到R3的标签映射信息该

怎么解决？

## 最终设备配置

```
<R1>display current-configuration
[V200R001C00SPC200]
#
 sysname R1
#
mpls lsr-id 2.2.2.2
 mpls
  lsp-trigger all
#
mpls ldp
 inbound peer 3.3.3.3 fec ip-prefix prefix1
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.12.1 255.255.255.0
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/1
 ip address 10.0.1.1 255.255.255.0
#
interface LoopBack0
 ip address 2.2.2.2 255.255.255.0
#
ospf 1 router-id 2.2.2.2
 area 0.0.0.0
  network 10.0.1.0 0.0.0.255
  network 10.0.12.0 0.0.0.255
  network 2.2.2.0 0.0.0.255
#
 ip ip-prefix prefix1 index 10 permit 10.0.12.0 24
#
return

[R2]display current-configuration
[V200R001C00SPC200]
#
```

```
 sysname R2
#
mpls lsr-id 3.3.3.3
 mpls
  lsp-trigger all
#
mpls ldp
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.12.2 255.255.255.0
 mpls
 mpls ldp
#
interface Serial2/0/0
 link-protocol ppp
 ip address 10.0.23.2 255.255.255.0
 mpls
 mpls ldp
#
interface LoopBack0
 ip address 3.3.3.3 255.255.255.0
#
ospf 1 router-id 3.3.3.3
 area 0.0.0.0
  network 10.0.12.0 0.0.0.255
  network 10.0.23.0 0.0.0.255
  network 3.3.3.0 0.0.0.255
#
return

[R3]display current-configuration
[V200R001C00SPC200]
#
 sysname R3
#
mpls lsr-id 4.4.4.4
 mpls
  lsp-trigger all
#
mpls ldp
#
interface Serial2/0/0
```

```
 link-protocol ppp
 ip address 10.0.23.3 255.255.255.0
 mpls
 mpls ldp
#
interface GigabitEthernet0/0/2
 ip address 10.0.2.1 255.255.255.0
#
interface LoopBack0
 ip address 4.4.4.4 255.255.255.0
#
ospf 1 router-id 4.4.4.4
 area 0.0.0.0
  network 10.0.2.0 0.0.0.255
  network 10.0.23.0 0.0.0.255
  network 4.4.4.0 0.0.0.255
#
return
```

# 在线学习资料支持

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